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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Telephone: Central 1885. Telegrams: CIRA.

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (Telephone 332).

Forthcoming Events.

OCTOBER 13.

Institute of Metals:—Sheffield Local Section. "Centrifugal Casting of Non-Ferrous Alloys," Paper by F. W. Rowe, B.Sc.

Manchester Association of Engineers:—Inaugural address by the President, T. B. Morley. Presentation of the Constantine and Butterworth Gold Medals.

OCTOBER 17.

Sheffield Metallurgical Association:—Meeting, at 7.30 p.m. "Exhaust Valve Failures," Paper by C. C. Hodgson.

OCTOBER 24.

Institution of Engineers and Shipbuilders in Scotland:—Meeting in Glasgow, at 7.30 p.m. "Flame-Cutting of Steel for Welded Joints," Paper by E. J. Clarke.

OCTOBER 27.

Manchester Association of Engineers:—"The Selection of Steels for Engineering Requirements," Paper by F. W. Rowe, B.Sc.

Institute of British Foundrymen.

OCTOBER 14.

Scottish Branch:—Meeting at Glasgow, at 4 p.m. Presidential address by J. Currie. "Nitricastiron," Paper by J. E. Hurst.

OCTOBER 20.

Iron and Steel Institute (West of Scotland Branch):—Meeting at Glasgow, at 7.15. Presidential address by A. McCance, D.Sc.

OCTOBER 26.

Birmingham, Coventry and West Midlands Branch:—Open discussion: "The Production of Sound Cast-Iron Castings." Joint meeting with the Midland Metallurgical Societies.

OCTOBER 28.

Lancashire Branch (Junior Section):—President's address, followed by lecture, "The Manufacture of Iron Castings for Enamelling and Galvanising," by F. Griffiths.

Sea-Water Corrosion.—II.

In giving a little further consideration to the results of the sea-water corrosion tests, the difficulty of compressing (for the convenience of our readers) the results obtained for a period of over fifteen years is very considerable, and those who wish to go into the matter in greater detail can be referred to the reports themselves.

As already indicated, tests in which specimens were exposed to the atmosphere, to alternate wet and dry conditions, and to complete immersion in sea water, show that, with the possible exception of a high-nickel and a high-chromium steel, cast irons are better than any other ferrous material, and this superiority is maintained for a period of years. To deal with the difference between the two cast irons tested, hot-blast and cold-blast, the relative corrosion for a five-year period for wrought and the Swedish iron and Armco, is taken as 100. The corrosion falls with the mild steels as the carbon increases, and is very low in the case of the irons, the hot-blast figure being 3.0 and the cold-blast figure 4.7. The cold-blast appears, therefore, to be slightly more liable to corrosion, but for tests of such length the difference is negligible, and it is quite possible that under slightly different conditions elsewhere the figures might have been reversed. In the case of alternate wet and dry conditions, which are known to be so much more severe than atmospheric conditions, the figure for wrought iron remaining at 100, the steels vary from 316 to 23. The hot-blast figure is 16 and the cold-blast figure is 11. In this case the cold-blast is slightly superior, but again the difference is negligible.

Under the conditions of complete immersion, the most severe of all as far as cast iron is concerned, taking wrought iron again as 100, the steels drop to 51 for the 13 per cent. chromium steel and to 63 for the 36 per cent. nickel steel. The hot-blast iron showed a figure of 60 and the cold-blast iron showed a figure of 62. While their relative superiority remains the same, the difference between the cast irons and the remaining ferrous materials is not so pronounced under conditions of complete immersion as under atmospheric corrosion, and the alternate wet and dry condition comes between the two.

These reports are also of value from the point of view of the steels, and particularly for certain steels containing copper. They would well repay careful abstracting on the part of an expert authority, with the object of throwing the behaviour of any one group of metals into relief as compared with the remainder.

Blaming the Refractories!

Often in visiting foundries we find that certain furnaces have been condemned because of the refractories used having failed to give an economic life. We, too, have had our troubles, and the solving of the problem of the provision of basic-furnace lining, capable of withstanding the action of molten steel and also of being a conductor of electricity, was probably the most difficult one the metallurgist has ever been called upon to solve, yet solved it was, and such furnaces now often yield a life of 1,000 heats.

The properties of refractories are well established, but variables, such as abrasion, furnace atmosphere and compression do have profound influences on their life. It is also true that special refractories are available for special purposes, but they are correspondingly expensive. Now it is constantly happening that a furnace is designed without adequate reference to the work likely to be placed on the refractories, and early failures introduce the question of better or more expensive material—factors which should have been envisaged before the ironwork was ordered.

The designers of furnaces can undoubtedly get much useful information from the catalogues of the refractory manufacturers or from co-operation with their technical staffs. There is, however, a distinct need for a plain statement by some co-operative organisation within the refractories industry which would list *types* of refractories, their relative cost and their properties as to refractoriness, expansion, abrasion and slag resistance, heat insulation and the like. The good reputation of many refractories has been impaired by designers incorporating the material for a wrong duty, and what is still worse, when a furnace has failed, the helter-skelter rush after any high-priced material and its subsequent indiscriminate use has been equally damaging. There is at the moment a wide range of really excellent refractory materials available, but they need more intelligence in application than is sometimes accorded to them.

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Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Visiting Cards.

To the Editor of The Foundry Trade Journal.

Sir,—I was interested to read your leading article on "Visiting Cards" and the article by Mr. Eric N. Simons which deals with the same subject. During a fairly long experience of selling I have found that quite 90 per cent. of the recipients of one's cards turn them over to see what is on the back. If they find a brief and concise list of the seller's main products curiosity is satisfied, and for that reason, if for no other, the list is entirely justified. To my mind it is the *front* of the card that matters most. A dotted line with the salesman's name written in is bad; it indicates that the seller's opinion of his own representative is not high enough to justify the small cost of printing special cards. That snobbishness does exist in every walk of life cannot be denied, and the sales manager should turn this to account by exalting the status of his representative in the eyes of the buyer, and thus securing interviews which might otherwise be denied. This can easily be done by providing visiting cards of a reasonable size, say 3 in. by 1½ in., bearing the representative's name in copperplate across the middle of the card. The bottom left-hand corner bears the title of the firm in smaller copperplate. The only other matter on the front of the card is the firm's telephone number. The buyer's reaction to such a card is that he is being waited upon by Mr. Smith, of John Brown & Company, instead of John Brown & Company's representative, Mr. Smith, and it is a curious psychological fact that most buyers lend a readier ear to one who they assume is at least a district manager than they do to a mere traveller.

I have tried to indicate a visiting card which is dignified, unobtrusive, carefully and economically worded, and which, I think, meets the best points made by you, sir, and by Mr. Eric N. Simons.—Yours, etc.,

H. W. Lockwood.

Winchester House, London, E.C.2,
October 5.

The Sesci Patents.

To the Editor of The Foundry Trade Journal.

Sir,—Some misunderstanding has been caused by the advertisements which were published in your valued paper regarding Patents Nos. 341,029 and 356,732 for "Improvements in or Relating to Furnaces Fired with Pulverised Fuel" and "Processes and Apparatus for the Heating by Means of Pulverised Coal of Furnaces of All Kinds, Fixed or Movable."

We would like to make it clear that these Patents have applications other than the rotary furnace, and that the advertisements in question only refer to these *other applications*.

It is a well-known fact that the licence for the application of the Patents cited to the rotary furnace has been granted in Great Britain to Messrs. Pittevil & Company, of Brussels, who are building the Sesci furnace in Great Britain.

We would be much obliged if you would be good enough to dispel the misunderstanding which has arisen.—Yours, etc.,

H. Garreau.

Auxiliaire Sidérurgique,
Rue du Moulin Allard,
Nanterre (Seine), France.
October 5.

Moulding Magnesium Castings.

To the Editor of The Foundry Trade Journal.

Sir,—We read with pleasure the account published in the Journal of the British party's attendance at the Prague Conference, which must have been both interesting and instructive.

We were particularly interested in the observation concerning the "unpleasant reaction on tender throats" of sulphur used in the making of magnesium castings. It is not so well known as it should be that we have in our natural product Colbond a bonding medium for moulding sands, an article which enables sulphur additions, for the manufacture of magnesium castings, to be considerably reduced, if not altogether eliminated. Magnesium castings have been successfully made in moulds bonded with Colbond with no sulphur additions.—Yours, etc.,

D. Lindsay.

24, Martin Lane,
Cannon Street,
London, E.C.4.
October 3, 1933.

B.C.I.R.A. Study Course.

The British Cast Iron Research Association is holding, on October 12, 13 and 14, a study course at its headquarters in Birmingham for the benefit of its members. We understand that the object of the course, attendance at which is confined to representatives of ordinary full members of the Association, is to review and survey the work of the Association during the past few years, to indicate its possible application in the industry and to link it up with existing practical experience and metallurgical knowledge. The mornings are occupied with informal talks in which the whole of the senior members of the staff of the Association will take part and the afternoons with practical demonstrations in the laboratories. Through the courtesy of the Directors of John Thompson (Wolverhampton), Limited, a visit is being arranged to the works for the purpose of seeing the balanced blast cupola in operation.

The interest taken in the course has been very much greater than was anticipated and may prove a source of some embarrassment in view of the rather limited accommodation available. The total number of registrations of members' representatives exceeds one hundred and fifty.

This move, which is believed to be new in the research association movement, has been arranged by the Council of the Association with a view to facilitating direct personal contact between the staff and members, thereby speeding up and simplifying the application of the Association's work to industrial practice. If, judging by the opinions expressed during and after the meeting, it appears to serve a useful purpose, the Council would be prepared to arrange similar courses at intervals, either general or dealing with special subjects. The present course includes moulding sands, core sands and refractories; cupola design and operation and other foundry melting furnaces; pig and refined irons; composition and structure of cast iron and its mechanical, physical and founding properties, and special irons, including inoculated irons; malleable cast iron, white-heart and black-heart, and finishing processes. The demonstrations will include the testing of moulding and core sands, physical and mechanical testing on cast iron, chemical analysis, microscopic examination and founding tests.

For the benefit of those members who are not able to be present personally, it is intended later to prepare the talks in printed form with a view of their circulation as research reports.

Book Reviews.

The Alloys of Iron and Silicon, by Earl S. Greiner, J. S. Marsh and Bradley Stoughton. Published for the Engineering Foundation by the McGraw-Hill Publishing Company, Limited, Aldwych House, Aldwych, London, W.C.2 Price 30s. net.

This monograph is the second product of the comprehensive task of providing a critical summary of the world's research on ferrous alloys undertaken by the Alloys of Iron Research Committee of the Engineering Foundation. Ample evidence of the real need for such critical surveys is to be found in the bibliography given in full at the close of the book. Actually 1,200 articles in many languages were consulted, and from this number 500 were selected, most of which are referred to in the bibliography. These are arranged in successive years, a method which discloses the enormous growth and wide distribution of published literature during recent years. For the individual metallurgist it is an impossible task to maintain close contact with the development of research and thought at the rate disclosed by this bibliography. There can be no fuller justification for this gigantic plan of the Research Committee. The great importance of the task demands that it shall be executed thoroughly and completely by those fully qualified by training, knowledge and experience. That such great care has been bestowed on the preparation of this monograph is clear.

The compilers of the book record their acknowledgments and gratitude to a long list of names; world-famed metallurgists who have assisted them by helpful reviews, criticism and suggestions. Eight chapters, virtually half of the book, are devoted to the constitution of the iron-silicon and iron-carbon-silicon alloys. From the point of view of those interested in the metallurgy of cast iron, this critical survey of the position of research, investigation and knowledge relating to these systems is of first-rate importance. The thorough treatment of this section in itself enables the book to be strongly recommended to all those interested in the metallurgy of cast iron. "The greatest single influence of silicon on the iron-carbon system which is of prime importance to the cast-iron industry is its graphitising influence on the carbide." This is recognised by the authors, and the reviewer cannot help but feel that the value of their work would have been enhanced if this subject had been treated separately under a single heading. Amongst all the work on the constitution of these iron-silicon alloys, that of the British metallurgists, Hanson, Haughton and Becker stands pre-eminent. One cannot help but record a sense of gratification in finding the arduous work of that band of workers at the National Physical Laboratory so amply justified.

One chapter of the book is devoted solely to high-silicon corrosion-resistant cast irons, which, in addition to giving some details of their composition and manufacture, describes their mechanical and corrosion-resisting properties. It is somewhat remarkable to observe that the composition range in the binary iron-silicon alloys, which includes these commercial acid-resisting alloys, is the one which is least understood. Data concerning the liquidus and solidus of the binary iron-silicon alloys from 10 to 15 per cent. silicon content is amongst that which is catalogued as being urgently needed. The remaining chapters are devoted to the properties and characteristics of the special steels in which the silicon content plays an important part. Heat-treatment data, mechanical, physical, electrical and magnetic properties are exhaustively and concisely reviewed. The monograph closes with a general summary followed by a short appendix and the complete bibliography.

The survey of the world's literature on the iron-silicon alloys has been exhaustively carried out and treated in an authoritative manner. This monograph must inevitably become the standard of reference on this subject. J. E. H.

Inverse (or Internal) Chill in Grey Cast Iron.*

By C. Howell Kain.

Introduction.

Although of comparatively rare occurrence, the defect or phenomenon known as inverse or internal chill in grey cast iron appears from time to time, causing great inconvenience and loss to the founder. Early writers on cast iron and pig-irons mention the defect in a general way, but without any attempt at an explanation. The impression is given that the phenomenon was much more common thirty to forty years ago than it is to-day.

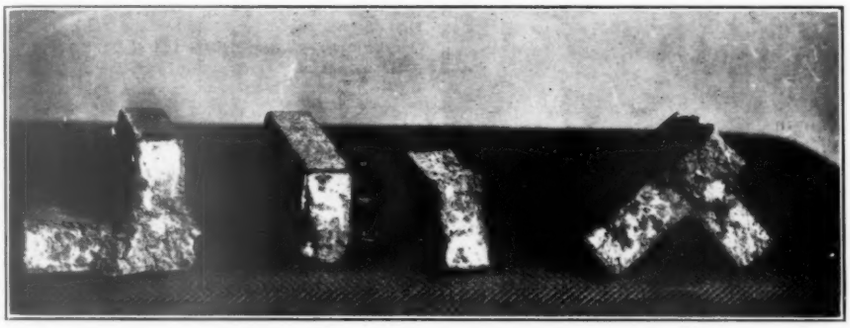

Fig. 1.—Fracture of Castings, exhibiting Inverse Chill.

Definition.

Fig. 1 shows the fractures of castings exhibiting the defect. The structure consists of a soft grey-iron layer or thick skin surrounding a hard white cementitic core. Fig. 2 is a photo-micrograph showing the grey iron of the skin, and Fig. 3 shows the cementitic core. An excellent illustration of the defect may be found in Dr. Norbury's Paper,[1] "Constitutional Diagrams for Cast Irons and Quenched Steels." The core often contains areas of grey iron, but the "chill" never penetrates to the extreme edge of the casting, the grey iron or graphite-bearing envelope being continuous.

In all cases within the experience of the writer the structure is readily broken down by simple heat-treatment, ordinary "normalising" treatment with reasonably slow cooling breaking down the metastable constituents of the white-iron centre (cementite, etc.) to the stable constituents, ferrite and graphite (temper carbon). Very little carbon remains in the combined state. Figs. 4 and 5 show the structure obtained by "normalising." In this condition the metal is very readily machinable, and phenomenal cutting speeds may be attained. The strength properties are fair, but inferior to those of pearlitic iron, and the material has very poor resistance to wear of any sort.

Occurrence.

The present writer first encountered the defect when producing high-strength irons in the high-frequency induction furnace. At that period (1928-29) considerable stress was laid by most authorities on the value of superheating cast iron to high temperatures. Full use was therefore made of the fact that the temperatures available in the high-frequency furnace are limited only by the quality of the refractories employed.

Casting temperatures were raised to upwards of 1,600 deg. C. (measured by optical pyrometer), but difficulty with the moulding sand caused the maximum to be set at 1,600 deg. C. The temperatures were carefully checked, and the metal poured into castings varying from ¼-in. to ¾-in. section, mainly in green-sand moulds.

Difficulty was soon found in machining, particularly in the heavier sections, due to the presence of masses of white iron in the centre. Investigation quickly established the following facts:—

(*a*) Inverse chill is largely independent of composition, as in the present case the defect was found with T.C. varying from 2.66 per cent. to 3.4 per cent., Si 1.0 per cent. to 2.0 per cent., P traces to 0.5 per cent., Mn traces to 1.0 per cent., Cr nil to 0.35 per cent. Ni was constant at 1.5 per cent. (but it is fairly certain that nickel is not a contributory factor), S was very low in all cases. It is, of course, probable that border-line compositions are more prone to the defect than compositions well within the grey range, but the phenomenon has been found in irons which would normally be very soft and grey.

(*b*) For the same thickness of section the defect was frequently found to be present in dry-sand moulds and absent in green sand (when cast from the same ladle). This tendency was noted even when the dry-sand casting section was much heavier than the green sand.

(*c*) There appears to be a critical casting temperature about 1,480 deg. C. From the same melt castings poured under 1,480 deg. C. have been grey throughout, and similar castings poured at over 1,480 deg. C. to 1,500 deg. C. have shown the defect.

The metal used to establish the above facts was all melted in a high-frequency induction furnace with a fritted (Rohn) lining, and from varied raw materials (pig-and-steel, hematite-and-steel, all-synthetic steel-graphite-ferro-alloy, etc.).

Causes.

There is very little published work on the subject, and practically none containing any useful suggestion as to the cause. Recourse was had, therefore, to private opinion, and a number of authorities on cast iron were consulted. Six main suggestions emerged, as follows:—(*a*) The steam or moisture theory; (*b*) the critical composition theory; (*c*) superheating *per se;* (*d*) the mould condition theory; (*e*) the pressure theory; and (*f*) the differential-cooling theory.

It is proposed to deal with each of these in turn. It must be explained here that the defect bears no relation to the Mn-S balance. In all the cases within the author's experience the sulphur was low, under 0.1 per cent., and manganese never less than 0.5 per cent.

The Steam or Moisture Theory.

Under this heading it is claimed that the defect has been associated with:—(1) Damp cupola hearths; (2) damp ladles, and (3) flat bottom in the cupola when using a receiver. In the case of the damp hearth or ladles the defect disappeared later in the melt, and in the case of the flat bottom a steeper slope, allowing the metal to run more freely into the receiver, overcame the difficulty.

Since the trouble ceased after the hearth and ladles had become thoroughly dry it was assumed that the defect was caused by steam. It is difficult to imagine the exact mechanism of the action, but it may be caused (1) by oxidation resulting from the dissociation of steam.

$$2H_2O \rightarrow 2H_2 + O_2$$

(2) by mechanical action of the gas (steam) preventing precipitation and growth of the graphite flakes, and (3) by a thermal effect resulting from the dissociation of steam and the combustion of hydrogen and/or carbon.

But since the castings are apparently mechanically sound, it is difficult to see how these complex reactions, involving several changes in volume of the gas, could take place and entirely escape from the freezing metal in the short solidification range. The instances quoted were obtained on border-line irons for cylinder work, and it is easy to imagine chill occurring in the early stages of the melt, due to oxidation, etc., from the blast. This is the reason for the occurrence when using a flat cupola bottom. Owing to the absence of slope the molten metal tended to lag on the flat surface, and would be subject to Bessemerisation by the air blast from the tuyeres, which, in a cupola incorporating a receiver, would be very near the bottom.

None of the above conditions obtain in the present writer's experience, since the metal was melted in the electric furnace, and was free from any danger of steam, air blasts, etc. Also, the ladles were quite dry and preheated in all cases. It is considered, therefore, that no useful conclusion can be drawn from this line of thought.

Fig. 2.—Grey-Iron Shell as cast; etched Picric Acid. × 200.

The Critical Composition Theory.

This suggestion is that the composition is critical, and that when

(1) Cast into dry-sand moulds, the sand in contact with the casting heats up very rapidly and anneals the outside of the casting, and

(2) Cast into green sand, the outer layers freeze very quickly, and compress the centre portions, so preventing the expansion necessary for graphitisation.

* A Paper presented to the Czecho-Slovakian International Foundry Congress on behalf of the Institute of British Foundrymen.

[1] J.I. & S.I., Vol. CXIX, No. 1, 1929.

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It is further suggested that most cases are a combination of the two actions, assisted by the destruction of all graphite nuclei by the high melting and pouring temperature. These hypotheses do not entirely fit the facts, the defect having been found in dry-sand castings when all the green sand ones have been perfectly grey. Also, microexamination shows the presence of flake graphite in the grey portions, and this could not be present if the graphite were formed by the annealing action of the hot sand on the white iron. In that case the graphite would be present in a nodular, or possibly a spidery form. Also, at the temperature of the separation of graphite it is difficult to credit that the outer envelope would be strong enough to resist the bursting stress caused by the expansion of graphitisation. Howe says very definitely that the tendency to form the stable phases, ferrite and graphite, is strong enough to overcome the pressure generated by its own expansion.

It is felt that none of these ideas accords completely with the facts, and that therefore they cannot account for the defect.

Superheating.

Dr. Everest drew the writer's attention to the work of Piwowarsky, showing that high casting temperatures are associated with high combined carbons, and suggested that annealing effects are produced by the heated sand. He recommended a lower casting temperature (1,300 to 1,400 deg. C.) and a high total carbon.

These suggested remedies fall in line with the findings of the writer, but the reasons for recommending them do not agree with the results obtained in experiment. In the first place, it is found that high casting temperatures are frequently associated with a ferrite-fine graphite structure and a very low combined carbon content, particularly in the thinner sections. This is confirmed by the work of the B.C.I.R.A. And for reasons stated under "*b*," it is not considered that the annealing effect of the sand is sufficient to cause precipitation of graphite.

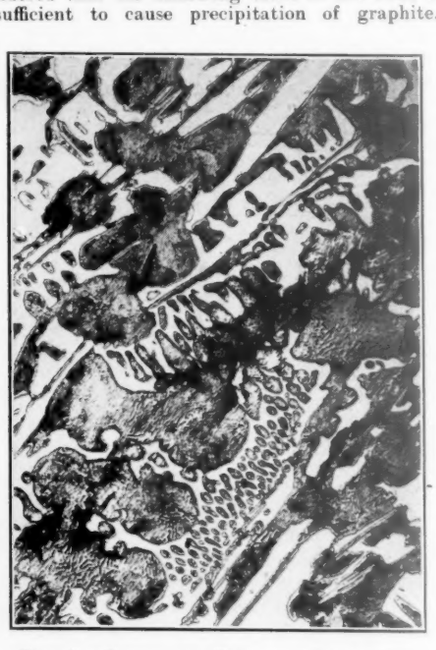


Fig. 3.—Cementitic Core as cast; etched Picric Acid. × 200.

The use of a lower casting temperature has, however, assisted in overcoming the defect.

The Mould Condition Theory.

This theory postulates that the defect is caused by casting a critical composition into green-sand moulds. If a chill mould had been used, the fracture would be white, whereas a heated dry-sand mould would have produced a grey structure. Fig. 6 illustrates an instance of the occurrence of mottled structure in remelted West Coast hematite, and Fig. 7 shows the same effect in cold-blast pig-iron. Further instances are cited of Swedish pig and of blast-furnace metal cast into wet pig beds. It is suggested that the superheat of the metal heats the sand of the mould and causes annealing of the outer layers,

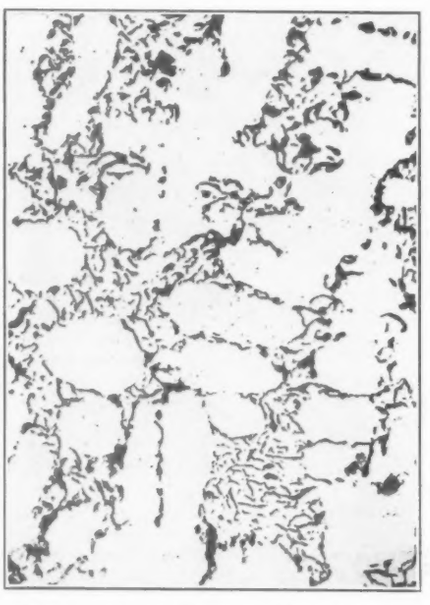


Fig. 4.—Grey Portion—Normalised; etched Picric Acid. × 200.

and that a lower casting temperature would have caused the whole section to be white. A casting temperature of 1,580 to 1,600 deg. C. into dry-sand moulds is recommended, together with increase of the silicon content.

These suggestions do not agree with the known facts. The defect is not a mottled structure in the usual sense, inasmuch as the outside is entirely grey, with the centre tending to be predominantly white. High casting temperatures seem to exaggerate the fault, particularly in dry-sand moulds, and it is not considered that the annealing effect of the sand is a serious factor. Also, it is difficult to imagine that a high casting temperature would retard the cooling of the outer layers and not the interior, unless there is differential cooling, which is discussed fully later. It is suggested that this explanation is not sufficiently comprehensive to meet all the facts.

The Pressure Theory.

Mr. J. G. Pearce (B.C.I.R.A.) suggested that an explanation of the defect might be found in Dr. Norbury's work[2] on superheating and graphite nuclei in cast iron. He states that superheated irons tend to solidify into a ferrite-fine graphite structure, and this structure is more liable to chill than the ordinary pearlite-coarse graphite structure; also that inoculation with graphitisers such as CaSi, FeSi, etc., prevents the formation of ferrite-fine graphite structures and precipitates pearlite-coarse (flake) graphite. This is in agreement with the findings of the present writer. Pearce states, further, that the inverse-chill structure has frequently been obtained with superheated crucible melts of grey iron, and suggests that the defect is caused by the outer layers being free to undergo the expansion necessary for graphitisation while the centre is "prevented from solidifying grey, with consequent expansion, owing to the pressure exerted by the contraction of the solidified outer layers."

2 J.I. & S.I., Vol. CXIX, No. 1, 1929; and Vol. CXXI, No. 1, 1930.

A consideration of the above suggests the following points:—

(1) It is difficult to see why the pressure of the outer layers should prevent graphitisation of the centre in the present case, where many of the irons contain 2 per cent. Si, when the defect does not commonly take place in borderline irons such as cylinder metal, containing <1.2 per cent. Si, or in chill rolls where the outside is chilled (quenched) and must exert the pressure much earlier in the freezing range of the centre than in the instance under discussion, where all the castings are made in sand, in many cases in dry sand.

(2) As has been remarked under "*b*," Howe considers that the tendency to form the stable phases, ferrite and graphite, is strong enough to overcome the pressure generated by their own expansion. It is presumed that the pressure from this cause, *i.e.*, expansion inside the rigid outer layer, is the greater portion of the pressure involved. Greater, that is, than the pressure due to the contraction of the outer layers, as the centre is also contracting somewhat.

(3) In the black-heart process free graphite is precipitated in the solid metal at the comparatively low temperature of 840 to 860 deg. C. This temperature is below the temperature of the separation of graphite in a grey iron during freezing, and therefore the iron body will be more rigid. This supports Howe's statement, and it is difficult to see why graphite should separate at this temperature and not at higher figures. The fact that the white-iron structure of an inverse chill breaks down very readily to graphite and ferrite under simple heat-treatment supports this argument.

In view of this, although the nuclei theory is generally accepted, it cannot be agreed that the pressure theory explains the presence of inverse chill.

The Differential Cooling Theory.

Mr. J. E. Hurst has suggested that a form of differential cooling may account for the defect, and the present writer is inclined to agree with this view. A short consideration will show that the speed or rate of cooling of the casting can vary. Fig. 8 shows a typical "rate of cooling" curve. The rate of cooling in degrees per second is plotted against the time (in seconds) from the commencement of cooling. If any point within the mass is considered, it will be seen that at the commencement of cooling the

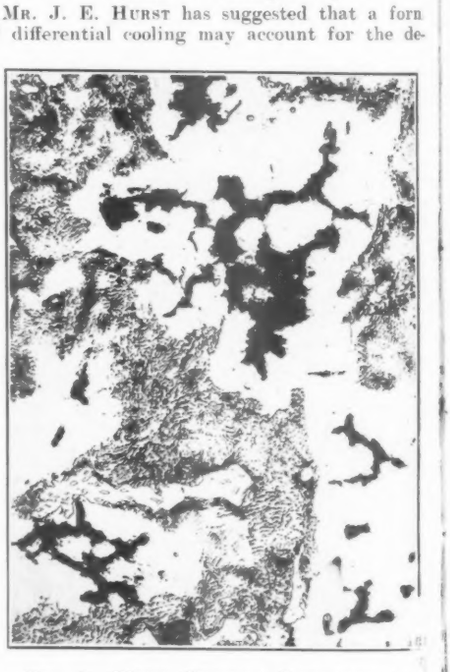


Fig. 5.—White Portion—Normalised; etched Picric Acid. × 200.

rate of cooling is zero, but that immediately heat is conducted away by the surroundings, the rate assumes a numerical value which rises to a maximum. This maximum may approach, or even exceed, the critical rate of cooling for any phenomena occurring at that time. As soon as the surroundings become heated, or their capacity for conducting or absorbing heat is affected by other factors, the rate of cooling of the point begins to fall. When the temperature of the casting falls to that of its surroundings, the rate is again zero. Obviously, a series of curves may be plotted for the full width or thickness of section, as shown in Fig. 9. The rise to the maximum rate is very rapid at the outside, as the metal is in contact with comparatively cold sand. The rate of cooling at the centre must lag behind that of the outside, because the heat is conducted away via

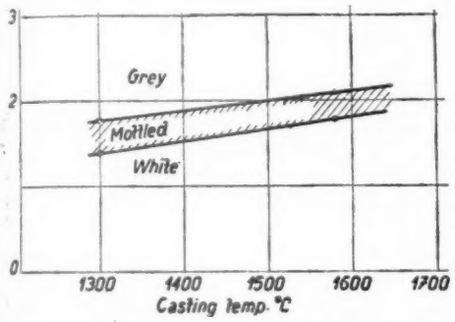


Fig. 6.—Occurrence of Mottled Structure in Remelted West Coast Hematite.

the outer layers of metal through sand which is already heated by absorbing the heat from the outer portions of the casting.

Now assume that the point of time at which the maximum rate occurs coincides with the point of time at which the metal is passing through the critical temperature (for the composition) of the separation of graphite. If the rate of cooling is sufficiently high, then "chilling" will occur, and the precipitation of graphite be prevented.

It is postulated that, although the outside may attain a higher maximum rate of cooling than the centre, this maximum occurs before the metal has cooled to the critical temperature of the separation of graphite, but that the maximum rate of cooling of the centre (occurring

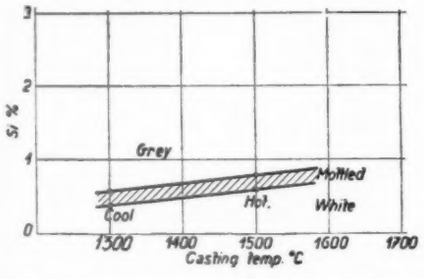


Fig. 7.—Occurrence of Mottled Structure in Remelted Cold-Blast Pig-iron.

later) is attained at the same time as the metal passes through the critical temperature. It is felt that this theory falls into line with all the known facts, and accounts for such anomalies as the presence of chill in the centre of a heavy section, whilst light sections of the same casting are perfectly grey.

Additional.

Since the above was written, the attention of the author has been drawn to a Paper[3] on this subject by L. F. C. Girardet, who suggests that the defect is caused by the presence of both white and grey iron in the liquid metal, the two phases not being miscible owing to the conditions of temperature, composition, etc. During freezing the grey iron, having the higher melting point, solidifies first and extrudes the white iron towards the still liquid centre. The presence of the white iron is caused by the use of white or mottled pig-iron, oxidised and burnt scrap, etc., and it is suggested that superheating will overcome the trouble.

This theory cannot be accepted, because:—(1) It cannot be agreed that the two phases of iron can exist in the same ladle, even if the charge has included mixed pig and scrap; (2) in the writer's experience, the defect has occurred both with pig and with synthetic mixtures melted in the electric furnace from carefully-selected clean stock and under reducing conditions; and (3) superheating definitely tends to aggravate the trouble.

[3] "Révue de Fonderie Moderne," October 10, 1931, Translated F.T.J., November 19, 1931.

Summary.

The puzzling phenomenon of inverse chilling has been examined in the light of modern thought, and most of the suggestions made have been based upon old theories which have been rejected. An entirely new suggestion has been put forward, and it is felt that this could be extended to cover many other problems in metallurgy and foundry practice. Before the publication of this Paper it is hoped to conduct experiments which may throw further light on the subject.

DISCUSSION.

Mr. J. G. Pearce (Director, British Cast Iron Research Association) said that he had read Mr. Kain's Paper with great interest. There was no doubt that the type of chill referred to was different from the ordinary chill due to wet sand or a chill mould. He believed that it is possible to recognise it microscopically. Any explanation of the formation of this type of chill must show why it is usually found inside the casting. There seems, however, no reason why it should invariably be so, and if it occurred at or near the edge of the casting its presence might erroneously be regarded as due to other causes, which often result in chilling at the mould face. If it does occur elsewhere than at the centre, another name might be preferable to "inverse" or "internal" chill, and the phrase "supercooled chill" might be suggested as appropriate, if supercooling be regarded as the cause. At present the general effects of superheating and the germ theory suffice to explain the phenomenon, in view of the following facts, established in the laboratories of the British Cast Iron Research Association, and given in the Paper by Norbury, referred to by Mr. Kain, and in a subsequent Paper by the same author and Morgan.

(1) If cast iron is superheated long enough and at sufficiently high temperature to dissolve the whole of the graphite, the metal on solidifying assumes the system ferrite-fine graphite, or with low silicon or with certain alloy additions, pearlite-fine graphite. (This fine graphite is the so-called eutectic or granular graphite, illustrated by Mr. Kain's Fig. 5 with ferrite and in Fig. 2 with pearlite.)

(2) If the graphite be not so dissolved, or if the melt be nucleated or inoculated with a graphitiser, the metal solidifies in the system pearlite-flake graphite, or ferrite-flake graphite if the silicon is high or cooling slow.

(3) The system ferrite-fine graphite requires more silicon to keep it grey than the system pearlite-flake graphite. In other words, it chills more readily. In the latter system a standard 1.2-in. bar is just grey with about 0.8 per cent. silicon, whereas the former requires 1.3 per cent. silicon for the same section. Thus it is easily possible for a low-carbon, low-silicon and superheated iron to have some areas solidifying in the former system, with insufficient silicon to keep the section grey, and other areas solidifying in the latter system, quite grey. This may explain white areas totally surrounded with grey areas. In the micrographs shown by Mr. Kain, Fig. 3 is a supercooled chill formed in this way, and the annealed structure, Fig. 5, shows what would be expected from an adjacent unchilled area.

The above completely explains the promotion of inverse chilling by superheating and graphite

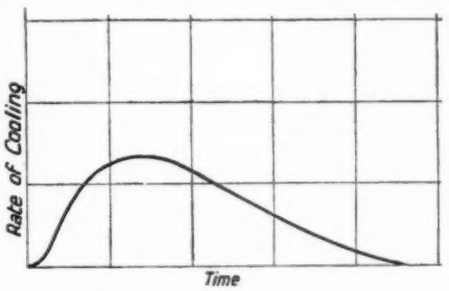


Fig. 8.—Typical Rate of Cooling—Time Curve.

refinement, and its destruction by nucleation (inoculation), lower superheating temperatures and higher carbon charges. It is in line with the complete independence of such chilling of moulding conditions and composition (within the limits used). The temperature of graphite solution is about 1,480 deg. C., which agrees with Mr. Kain's experience. The explanation can also readily be arranged to agree with explanation C, based on the work of Piwowarsky. The writer deprecates labelling the suggestions the pressure theory, because pressure was suggested only as a means of explaining why this type of chill is invariably internal, but as indicated above, is not satisfied that it need be wholly internal. Unfortunately, if it does occur elsewhere, it is so difficult to distinguish from chill arising from other causes. The rare occurrence of supercooled chill at the edge of a casting may be due to inoculation from mould material, such as coal dust. Supercooled graphite is quite common at the edge of thin castings where the metal would freeze before an inoculant had time to take effect.

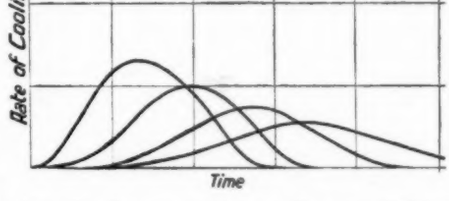


Fig. 9.—Series of Rate of Cooling—Time Curves plotted for Full Width on Thickness of Section.

Creosote Fuel in Furnace.—The British Standards Institution has just issued a specification for creosote for fuel in furnaces (B.S.S. No. 503—1933), which should prove extremely useful to the users of this class of fuel, in boiler installations. The specification provides for creosote produced as a distillate of coal tar, and which must be free from admixtures of petroleum oils, or undistilled crude tars. The specification includes requirements for the physical properties of the material, such as specific gravity, viscosity, water content, matter insoluble in benzole, fluidity, flash point, ash and calorific value. Details as to the method by which the tests for the determination of these requirements are to be carried out are given in appendices to the specification. Copies of this specification (B.S.S. No. 503—1933) can be obtained from the Publications Department, B.S.I., 28, Victoria Street, S.W.1. (Price 2s. 2d. post free.)

The Present Position and Prospects of the Foundry Industry.

The East Midlands Branch of the Institute of British Foundrymen opened its Winter Session at the Nottingham University College on Saturday, September 30, 1933, Mr. C. W. Bigg, introducing the new President, Mr. P. A. Russell, of Leicester, assured him of the best wishes of the branch for a successful year of office. Mr. Russell gave his inaugural address, in the course of which he said:—

Mr. Bigg and Gentlemen,—The present are stirring times in the cast-iron industry, as it is passing through a very considerable phase of transition at the present moment. Two decades ago there was talk of the trade being a dying branch of industry owing to the developments in other branches of metallurgy. Firstly, there was the displacement of cast iron for building purposes by rolled-steel sections, and latterly the use of welded steel in place of large single castings. This latter process is still evolving and founders have to face the fact that even larger quantities of work will be transferred in what might be called the "one-off" trade, in which the welding industry has such a financial advantage. Metallurgically the change-over from castings to fabricated structures is to be deplored, for it is felt that in most instances the iron founder can give a better job, particularly in structures that are intended to have a long life.

On the other hand, the developments in the cast-iron industry are such that there is no reason why it should not make up for this lost ground in other directions and continue to expand. One of the most marked of these developments is in the matter of strength of cast iron. In recent years the strength of the average casting has increased by one-third. This is not entirely due to a desire to increase strength, but has been done in many cases unconsciously because the better understanding of metallurgy has brought about changes in the type of mixture used, for the foundryman's own advantage. Also the improvement in cutting tools has enabled the founder to get away from the old fetish for "softness."

Then the development of alloy and processed cast irons has greatly expanded the usefulness of cast iron, and to meet the demand for better and better material that is such a feature of modern industrial conditions. These irons have even claimed for cast iron, fields that were previously considered to be exclusively confined to other materials. The outstanding example of this is the cast-iron cam shaft, but many other applications are unobtrusively making themselves felt, particularly in the field of heat and corrosion resistance. Added to this, alloy and processed irons can now be obtained to give tensile strengths regularly over 20 tons per sq. in. and sometimes up to 30 tons per sq. in.

The development of the rotary furnace is another very interesting feature, and one that is certain to play a considerable part in the development of cast irons in the near future. In this connection it is pleasing to announce that a visit has been arranged for December 9 to the works of the Wycliffe Foundry Company, Lutterworth, to see the "Sesci" rotary furnace.

Enough has been said to substantiate the original statement that one is living in stirring times in the foundry world. The grey-iron industry will gradually divide itself into alloy or processed and ordinary iron in the same way that the steel industry is divided into special and mild steels. The ordinary iron industry will not die out—on the other hand, it is not thought that alloy or processed irons could be usefully applied to more than 10 per cent. of the present cast-iron field.

A development worthy of reference, though this applies to all foundries, not only the grey iron, is the trade depression through which industry has passed and from which it is only just beginning to emerge has thrown founders so much upon their own resources that they have had to improve the technique of founding so that production costs shall be at an absolute minimum, and this will surely bear fruit when the more plentiful times come.

Now where does the Institute enter into all this? It is the largest single force in disseminating the knowledge of these improvements in this country, and without the Institute, where would published knowledge of many of these developments be? True, the force of the technical journals and advertising is very considerable, but advertising is necessarily one-sided, whereas in the discussions that follow Institute Papers the experience of others on similar problems is brought out, so that a truer conception of the value of the subject under discussion is obtained.

It has been said from this chair many times that the discussion is often quite as informative as the Paper from which it originates, and all must make a real effort to participate on every occasion.

Then the Institute has recently formed a Technical Committee, one of the principal objects of which is to co-ordinate existing knowledge. It also carries out investigations into pressing problems in the industry, and it is believed that valuable contributions to the knowledge of founding will come from this source. There have already been published valuable reports from the Malleable and Sands Committees, and the Cast Iron and Non-Ferrous Committees are giving their first technical reports to the next conference.

The members gathered here are sufficiently convinced of the advantages of membership of the Institute to need no further inducements, but they should appeal to their friends and convince them of these advantages and get them to become members.

It is not pleasant to announce that the membership of this Branch has fallen by 17 from its peak in 1929, probably because of the state of trade, but there is some satisfaction that this falling-off has not been even greater, but now that things are improving it is hoped members will all make an effort to regain this lost ground. The figures submitted do not include the Lincoln Section, which has been formed during this period and so helped to swell the numbers on the books. This, however, is a separate entity, and one cannot disguise the fact that the true East Midlands membership has substantially decreased.

Mr. A. E. Peace (Vice-President) said it gave him very great pleasure to propose a vote of thanks to the President for his helpful and encouraging address. This was seconded by Mr. Robins.

The President then called upon Mr. R. Spriggs, of Loughborough, to present his Paper on "Foundry Conveying and Handling." The Paper was illustrated by lantern slides and films, and was supported by further films shown by Messrs. Coggon and France, of Messrs. August's, Limited.

Analysis of Special Steels.—In the "Zeitschrift für Analytische Chemie," W. Hiltner and C. Marwan report the results of investigations on the estimation of Cr, Mn and V simultaneously in special steels using a twin-tube potentiometer and a silver-iodide electrode along the lines evolved by P. Dickens and G. Thanheiser and by R. Lang and F. Kurtz.

Alloys of Iron and Manganese.

At the autumn meeting of the Iron and Steel Institute, held at Sheffield on September 12 to 15, Sir H. C. H. Carpenter, Ph.D., F.R.S. (Acting President) in the chair, Dr. Marie L. V. Gayler read a Paper on "The Constitution of the Alloys of Iron and Manganese." We append the summary.

The constitution of the iron-manganese alloys has been determined by means of thermal, microscopical and X-ray examinations of alloys made from high-purity electrolytic iron and distilled manganese. In comparison with previous determinations, the position of the liquidus and solidus has been appreciably raised and the existence of a peritectic reaction between γ-iron and liquid to form γ-manganese has been confirmed.

The δ-γ iron transformation has been found to take place at 1,504 deg. C. over a range of composition of 1 to 8 per cent. of manganese; γ-iron then separates directly from the liquid state, until at a temperature of 1,270 deg. C. it reacts with the manganese-rich liquid to form a phase containing approximately 68 per cent. of γ-manganese. This peritectic reaction extends from 65 to 74 per cent. of manganese, after which the γ-manganese phase separates directly from the liquid on cooling. The constitution in the solid state of iron-rich alloys has not yet been solved.

The changes in the solid state of manganese-rich alloys have been very carefully determined by means of the thermal, microscopical and X-ray analysis of a number of alloys. The γ-manganese phase is shown to decompose into γ-iron and β-manganese at a temperature of 1,028 deg. C. over a range of composition of 64 to 72 per cent. of manganese, and similarly the β-manganese phase has been shown to decompose into γ-iron and α-manganese at 600 deg. C. over a range of composition of about 59 to 63 per cent. of manganese.

An appendix on the X-ray structure of manganese-rich alloys quenched from various temperatures is given.

Fifth International Foundry Congress.

Mr. C. E. Hoyt, the secretary of the American Foundrymen's Association, announces that his board of directors has voted unanimously to hold the 1934 Convention and Exhibition of the Association in Philadelphia, and to arrange a Convention without an exhibition for 1935. Mr. Hoyt also announces that the International Committee of foundry technical associations has awarded to the American Foundrymen's Association the honour of holding in the United States in 1934, the Fifth International Foundry Congress and Exhibition. The staging of this important event in connection with the annual convention of A.F.A., which is usually held in May, has been set for the week of October 22, a date following the annual conventions of the co-operating European associations.

The overseas countries whose foundry associations are members of the Committee on International Congresses include Great Britain, Spain, Belgium, Czecho-Slovakia, Italy, France, Germany, Hungary, Poland and Holland. The first International Foundry Congress was held in Paris in 1923, the second in Detroit, U.S.A., 1926, the third in London, 1929, and the fourth in France, 1932. Sixteen foreign countries were represented in the attendance at the International Congress at Detroit.

It is the plan of the directors that the 1935 Convention without an exhibit shall be similar in character to the very successful one held at the Edgewater Beach Hotel in Chicago in June, 1927, following the International Foundry Congress held in Detroit in the autumn of 1926.

The Crucible Process and Metallurgical Developments.

So long as there are metals in the world to be melted, so will opinions differ as to the best methods to employ. Fuels are many and varied, but the most popular are still undoubtedly coke and oil. Electric furnaces have of recent years been employed more and more for certain work, and a more recent development is the pulverised-fuel furnace.

Apart from the question of fuel, however, there are the different types of furnaces which have their advocates for the melting of non-ferrous metals, and in this direction the bone of contention is whether the old and well-proved crucible furnace has anything to justify its retention since the modern type of reverberatory furnace has been introduced. The subject is a difficult one, and from opinions we have sought we can only conclude that both methods have their well-defined fields—their advantages and their disadvantages—and it would appear that on many points non-ferrous metal melters will continue to "agree to differ."

The controversy which has been raised in the technical Press from time to time has caused us

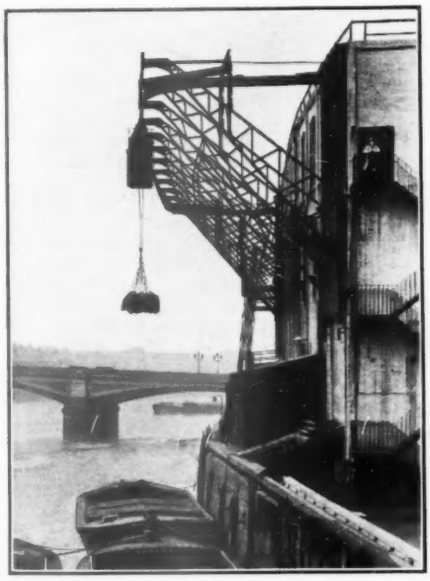


Fig. 1.—This Crane, used for unloading Boats at the Morgan Crucible Works, is a prominent Water-front Feature of London.

to visit the Morgan Crucible Company, Limited, of Battersea, who have the largest crucible works in the world, to find out for ourselves how they are progressing. We found them very ready to discuss any aspect of their business and to give us a clear insight into the extent of their activities and to conduct us over various parts of the works, including also the test foundry, laboratory and warehouse.

The Manufacture of Crucibles.

It would not be out of place to mention here that we were particularly impressed by the meticulous care which is taken by this firm in every stage from the receipt of the raw materials to the final packing of the finished crucibles.

The works occupy an excellent site on the south bank of the Thames, which enables the raw materials to be brought by boat right up to the works, and provides facilities for despatching by barge to the docks the large consignments of crucibles which are regularly sent to all parts of the world.

The ingenious overhead crane illustrated in Fig. 1 is used for unloading the raw material from the boats lying alongside. The bags are picked up by the crane and conveyed into the top floor of the mill, where they are eventually emptied into appropriate bins. Before being removed from the raw material stores they are analysed and graded by the laboratory staff. The importance of this cannot be over-emphasised, as the onus is placed upon the firm of producing standardised articles from materials yielded up by nature. A view of the laboratory is shown in Fig. 2.

Continuous Research.

A large research staff is kept busily employed in a constant endeavour to improve the mixtures of various raw materials to give the longer life from the crucibles which the user ever demands. The large variety of existing

Fig. 2.—The Laboratory at the Works of the Morgan Crucible Company.

"standard" mixtures is described as being absolutely essential to meet the many present-day melting problems with their combinations of type of furnace employed, fuel used and class

Fig. 3.—One of the Shops constituting the Demonstration Foundry at the Morgan Crucible Company.

of metal melted. Each of these has a distinct bearing on the choice of "mixture" used in the manufacture of the crucible, the method of making and the manner in which it is kilned.

The accumulated experience of over 75 years places the Morgan Crucible Company, Limited, in a unique position to deal with these matters. We were given many instances where close co-operation between the user and manufacturer had resulted in the supply of a different type of crucible more suitable for the melter's particular conditions, which had led to an appreciable increase in the life of the crucible, this in turn meaning lower melting costs to the founder. Service of this nature is freely at the disposal of any customer, and no doubt many more could benefit by a frank discussion with the crucible manufacturer of any particular melting problems.

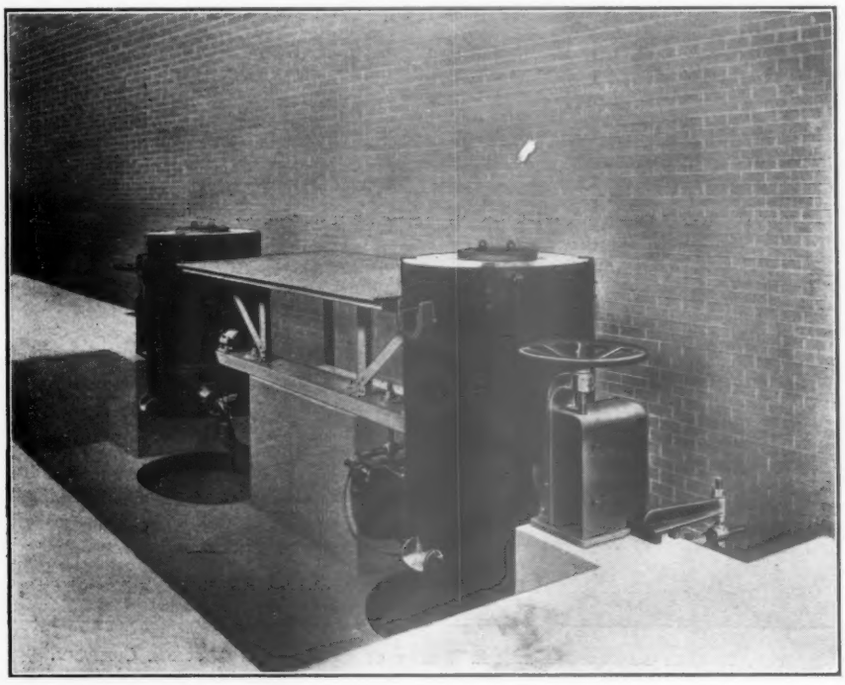


Fig. 4.—Two 30-cwt. Capacity Morgan Crucible Furnaces destined to work in an Aluminium Foundry.

A Demonstration Foundry.

There is at Battersea a separate and special department created for the foundryman's particular benefit. A general view of this department is shown in Fig. 3. This double building is equipped in such a manner as to eliminate for the purchaser any question of buying a "pig in a poke." Here is installed a range of Morgan furnaces, stationary and tilting, coke and oil fired, all at the disposal of the industry for making its own tests. Their own particular alloys can be melted and cast into moulds. The fuel consumption can be measured, test-pieces taken away and submitted to examination, whilst actual castings can be tried out for soundness and other properties.

A Mighty Crucible.

The success of the modern crucible process depends mainly on a phase of metallurgical thought which is insufficiently appreciated. Unlike any other metallurgical method of melting, except perhaps the high-frequency induction furnace—the bath is quiescent and deep, and presents a minimum surface for oxidation. In our considerable experience of electric furnaces we found that the best (but not necessarily the most economical) results were to be associated with a deep bath. We doubt whether any method of melting non-ferrous metals would yield such low metal losses, especially on brasses, as the modern crucible furnace. We use the word "modern" as such great strides have been made in recent years, and in conjunction with greatly increased life of pots, there has been an almost startling development in furnace capacity. Actually 30-cwt. furnaces are now being made, and we hope in the near future to devote some space to a detailed description of the operating details of such an installation. In the meantime we reproduce (Fig. 4) a photograph of two 30-cwt. furnaces about to be installed in a large aluminium works.

It will be well realised from the above that there exists, centrally situated, a well-equipped service station at the disposal of the foundry industry, and capable of yielding to it a wealth of information as to cost and quality of its metals and alloys, when melted in the latest types of crucible furnaces.

Edgar Allen & Company, Limited.

WORKS VISITED BY THE IRON AND STEEL INSTITUTE.

Mr. William Edgar Allen commenced business in 1868 more particularly as a general merchant, though he specially concentrated on the manufacture of tool steel and files, in which products he speedily built up a considerable foreign trade. Subsequently he purchased the business of Hoole, Stainforth & Company. In 1890 Mr. Edgar Allen was joined by Mr. Robert Woodward and Mr. Alfred E. Wells, and the business was converted into a limited liability company under its present style in 1892, the site of the works at Tinsley being taken over a year previously.

From this time the growth of the works was very rapid; a steel foundry was put into operation and one of its earliest results was the successful production of steel castings for dynamo magnets, which, up to that time, had been made of wrought iron. In 1903 the business of Askham Bros. & Wilson, Limited, was taken over. This was an acquisition which ensured for the company an outlet for their manganese steel for tramway work and the various component parts of crushing and grinding machinery, directions in which the company have since developed considerably.

Tool-Steel Melting Department.

In this department Edgar Allen were responsible for an innovation which may well be said to have revolutionised the manufacture of high-speed tool steel. Recognising the necessity for a tool steel which would task the machine tool to its utmost and thus ensure maximum efficiency, Edgar Allen & Company had for many years been carrying on researches as the outcome of which, combined with costly experiment, they introduced the "Stag Major" high-speed steel, in the production of which it was necessary to make additions of very expensive alloying elements, necessitating special methods of production and very careful preparation.

It was imperative that the heavy elements contained should permeate the molten metal and create a homogeneous mass. This was only rendered possible by the introduction of a new high-frequency electric furnace, which was indeed the first of its kind in the world to produce high-quality tool steel on a commercial scale. In this furnace the molten mass of high-grade pure base metal is kept constantly on the move owing to the complex electrical field in which the materials exist, whilst as the steel produced does not come in contact with any gases, the extreme purity of the base metals is preserved.

It may be interesting if we refer here to the application of the "Stag Major" steel. Naturally the first cost is high, but the steel far outweighs its cost by the results obtained. To meet the needs of the smaller users, who either could not afford so high-class a steel, or whose machines were hardly adapted to its use, tools tipped with the steel were next developed. The cutting qualities of such tools were excellent, but the strength and rigidity left something to be desired. The weakness did not appear to lie in the braze or in the "Stag Major" itself, but seemed to spring from a combination of the two, resulting in a strained tip which was prone to split when subjected to heavy pressures or shocks. The trouble referred to has now been entirely overcome by electrically welding on to a shank an end of the special steel, generally of the same section as the shank itself. Twist drills made on this same system have stood up to drilling the webs of manganese-steel rails, both rolled and cast.

In the high-frequency furnace is also melted cobalt steel for permanent magnets, the steel being made in both bars and castings.

The Steel Foundry.

The steel foundry is amongst the largest in this country and castings for practically all purposes are produced in all classes of steel. Recently considerable developments have been made in the production of light steel castings of a nature which hitherto had been made in malleable iron, particularly for the electrical trade, such, for example, as switchgear castings, interpoles, etc.

Stainless steel in sheets, bars and castings now forms an important branch of the company's activities. The melting plant consists of a Héroult electric furnace.

The sections dealing with railway and with tramway-track work were originally divided into distinct departments, but are now operated as one large trackwork department. All castings for tramway work, such as crossings, points, vee pieces, drain-box lids, etc., are made in "Imperial" manganese steel. The buildings comprise a large machine and grinding shop which is jointly occupied by the two departments. The machine and grinding shop is divided into two bays, one 375 ft. by 160 ft. and one 425 ft. by 160 ft. The shop is served by three 2-ton electric cranes in each bay. The equipment includes hydraulic presses, pumps, accumulators, grinding, drilling machines, etc.

A Special Cast-Iron Vessel.

This cast-iron vessel, which was made by John Varley, Limited, of St. Helens, for Imperial Chemical Industries, Limited, measures 14 ft. 2 in. dia. by 17 ft. 6 in. high. It was divided into four main castings, consisting of two cylinders, each of 13 ft. 6 in. inside dia. and 6 ft. deep, one 3 ft. deep cylinder and one cast-iron bottom. The bottom, made in one piece, was heavily ribbed and carried six bracket-feet on the underside, on which the complete vessel was supported when in working position. The weight of the cast-iron bottom and of the two larger cylinders was 8 tons each when machined.

Fig. 1.—Showing the Cast-iron Bottom of the Vessel.

All four castings were moulded with a 12-in. feeding head, and all flanges were solid when machined. To the ordinary foundry, castings of this size would be out of the question, owing to the very large size of drying stoves and massive tackle required in moulding.

Since they were intended for use as part of a chemical plant, the castings were naturally required to possess a very close grain so as to give exceptional resistance to corrosive action; and also to comply with a very strict chemical analysis which specified low total carbon, silicon and sulphur. To meet these demands and to give complete freedom from flaws throughout the structure of such massive castings, it was considered necessary to treat the metal with sodium carbonate. The running of the castings constituted one of the chief problems, as their outside circumference was over 42 ft. and the general practice of running cylinders with ingates in the bottom consequently not feasible. The three cylinders were therefore run with 18 drop runners from the top, fed from a common circular running basin, which went right round the top of the cylinder. The difficulties in running the cast-iron bottom were not overcome so easily, as, owing to the considerable number of ribs and the supporting brackets, which were all cast on the underside, the running of these castings from anywhere but the lowest point was not thought advisable. It was accordingly run with twelve 1-in. gates into the bottom outlet branch, which passed through the centre of the casting.

Notwithstanding the large diameter of these castings, no difficulty was experienced with the contraction, and the bolt holes cast in the flanges were all linable on erection. All four castings had machined flanges, which when bolted together had a machining limit of 10/1,000. The complete vessel, when erected and filled with water, had not to have a variation of more than 10/1,000 on any of the six supporting feet.

Owing to the size of these castings it was impossible to convey them by rail. They had to be delivered by road, and delivery was carried out by the L.M.S. Railway Company.

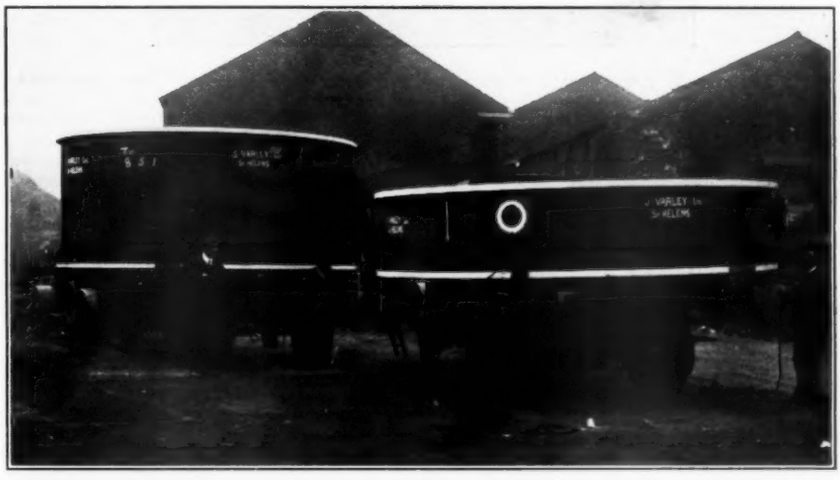


Fig. 2.—Showing (Left) View of the Longest (6-ft. Drop) Castings, and a Similar Casting for the Same Vessel.

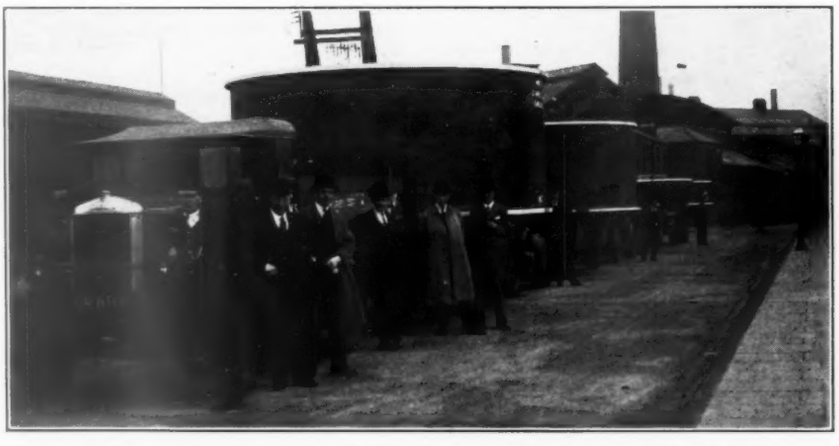


Fig. 3.—Showing all Four Castings, by Messrs. John Varley, Limited, loaded on Trailers.

Catalogue Received.

Valves.—It is always interesting for us to follow the progress which the foundry industry is making in its methods of publicity, and an examination of a catalogue just received from Messrs. Gummers, Limited, Effingham Valve Works, Rotherham, is particularly worthy of mention, as having reached a particularly high standard.

The brochure, which is Section E of their catalogue No. 33, deals with Twintite plunger valves. It runs to 16 pages and is well illustrated. Not all the valves shown are castings, some of them being of forged steel, but they are also made as bronze, iron and steel castings. A code word has been evolved for each type, whilst full specifications are also included. We note that in many cases the valves are fitted with "Farronic" seatings, and some little definition of this alloy might be added for such persons as ourselves who are unaware of its nature.

We congratulate the officer responsible for producing this catalogue and also the printer for his care in ruling up the various "boxes" of tables.

Case-Hardening of Metals.—In "Suiyokai-shi," D. Saito and H. Okawa describe the hardening of powdered Fe, Mn, Cr, Al, Ni and Co by treatment in a current of ammonia at 100 to 1,000 deg. C. The formation and decomposition of the nitrides of these metals was also studied.

"Longenecker" Interlocking Furnace Arch.

AID TO SURFACE ROOF REPAIRS.

We append particulars of a type of suspended furnace arch recently introduced into this country. The tiles are interlocking, and an improved method of cantilever suspension is adopted, affording great advantages from the standpoints of economy in initial outlay and furnace maintenance, whilst at the same time contributing substantially to a higher standard of furnace efficiency.

Fig. 1.—Showing Details of "Longenecker" Interlocking Furnace Arch Construction.

Our illustrations of the various components of the design are almost self-explanatory. Fig. 1, *a* shows the shape of tile employed, *b* the type of suspension, whilst *c*, *d* and *e* indicate clearly the method of assembly. It will be noted that some tiles on one side carry a raised inverted Vee-shaped portion, with a corresponding recess on the opposite side, so that the tiles are effectively interlocked, and horizontal fractures at or below the suspension groove do not lead to portions of tile falling into the furnace. Every fifth or sixth tile has a plain keyless surface to facilitate removal, and individual tiles can be easily changed, it being never necessary to remove more than five or six adjacent tiles. This is evident from the construction shown in Fig. 2.

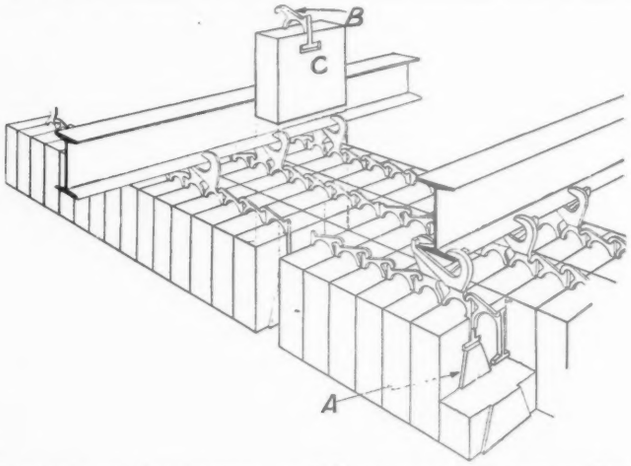


Fig. 2.—Diagrammatic Arrangement of "Longenecker" Suspended Furnace Arch.

A = Interlocking tile. B = Cast-iron hanger.
C = Tile with keyless surface to facilitate removal.

As regards the link-type hangers employed, the larger hanger or beam casting is so designed that it directly engages with the flange of the roof beam (*b*, Fig. 1). The small hanger or tile casting then links on to the beam casting, as shown at *e*, Fig. 1. The hanger castings, though required to carry less than 150 lbs., will support a load of some 4,000 lbs., so that they possess an ample margin of strength. The small area of furnace roof occupied by the suspensions themselves is such that about 92 per cent. of the roof may be insulated without endangering the metallic parts.

The interlocking feature of the "Longenecker" design is also applied to nose construction, and provides a rigid and leak-proof arch at the point of hardest service. The interlocking furnace nose (Fig. 3) is supported by a simple arrangement of standard beam sections. Tiles to form vertical walls are the same as used in the arch proper. All nose tiles are interlocked and of suitable size and thickness, permitting maximum refractory service. Every third nose tile is notched to accommodate a hanger casting. The nose tiles are held in position by the metallic hangers as well as being supported by projections from the roof and vertical wall. They are also mutually interlocked. All supporting castings are hung and not bolted, a feature which makes installation simple and replacement easy. The interlocking furnace nose furnishes a full thickness of refractory at that section of the nose where the furnace temperatures and flame conditions are the most severe.

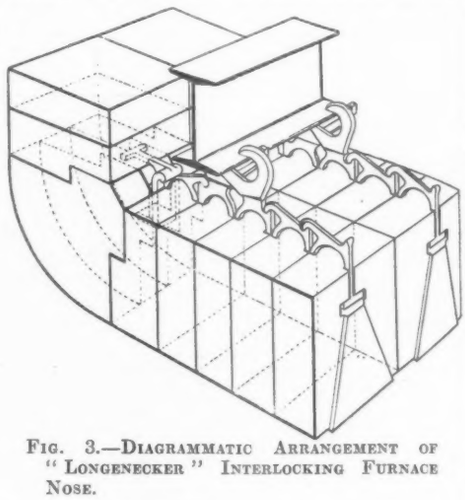


Fig. 3.—Diagrammatic Arrangement of "Longenecker" Interlocking Furnace Nose.

Messrs. Basic Industries' Equipment Company, Limited, 53, Victoria Street, London, S.W., are the sole selling agents in Great Britain.

Welding Symbols and Definitions.

The British Standards Institution has issued British Standard Nomenclature, Definitions and Symbols for Welding and Cutting (B.S. No. 499—(1933). Two objects have been kept in view in preparing this standard. One, to establish agreement as to the exact meaning to be attached to terms that have become associated with welding practice, and the other, to draw up a standard system by means of which the form and details of welded joints can be readily indicated on engineering drawings. In the Standard welding terms have, for ease of reference, been grouped under five main sections as follow:—Section I: Definitions of general terms applicable to all forms of welding and also including cutting terms; section II: Definitions of methods and joints relating to forge welding; section III: Definitions of methods, terms and joints relating to pressure welding; section IV: Definitions of methods, terms and joints relating to fusion welding; section V: Definitions of terms relating to welding and cutting equipment and supplies. A complete alphabetical index has been included so that the definition number of any term can be easily found and the term readily traced. Where desirable, in order to prevent the possibility of misunderstanding, illustrations and diagrams have been inserted. The standardisation of a system for the indication of welds on engineering drawings was one which presented no little difficulty and it occasioned much thought and careful consideration on the part of the Committee. It was felt that for a standard scheme to be really successful it was essential that it should possess the following three main characteristics:—(*a*) It should be simple, easy to adopt and readily followed; (*b*) it should be comprehensive and cover as wide a range of welded joints as possible; (*c*) it should be adaptable so that it would be possible to indicate the variations that may occur in the details of joints of the same general form. The Committee felt that these essentials could not possibly be met by means of diagrammatic symbols and they have accordingly put forward a system in which a capital letter is used to indicate the general form of joint, such as "B" or "T" for a butt joint and tee joint respectively, and a combination of numbers and suffix letters is appended to indicate the particular form of weld, while there is also a statement of the dimensions to be given. Copies of B.S. No. 499—1933 can be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1. (Price 2s. 3d., post free.)

Spur Wheel Castings.

By F. Oldershaw.

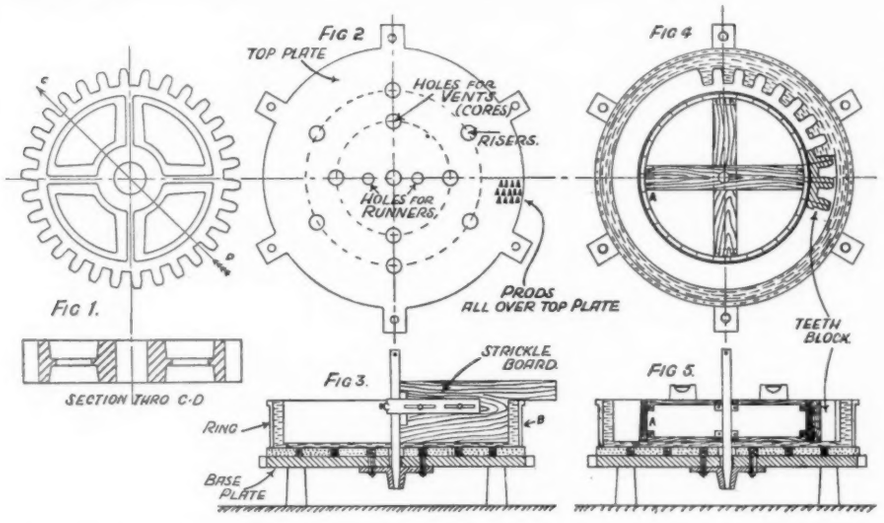
The following method describes and illustrates a method of making spur wheels where a tooth-wheel machine is not available. The method is reasonably quick, inexpensive, and if carried out with due care it gives accurately-dimensioned casting.

Patterns.

The patterns required include a strickle-board to sweep up the bottom bed and the dummy sides, as shown in Fig. 3; a built-up ring, with cross pieces fitted and with a hole bored in the centre to fit snugly over the spindle, and a tooth-block consisting of three or more teeth. Apart from coreboxes, this constitutes the whole of the pattern work required. The ring, which acts as a guide for the tooth-block, must be perfectly round yet strong, as this determines the truth of the pitch circle. This ring can be given a good taper from top to bottom and the tooth-block is tapered the opposite way to facilitate the withdrawal of the tooth-block without much rapping. The top edge of the ring A (Fig. 4) is set out and centre lines marked plainly with a sharp scriber, the number of centre lines will be the same as the number of teeth required on the wheel. This ring can be used for different-sized wheels if the top layer be replaced with one bearing different centres to suit the number of teeth required, and a tooth-block made for the purpose. In the case of a very large wheel, this guide ring can be replaced with a dummy struck up in loam and dried. In this case it should be about one inch less than the width of the teeth, and a wood ring fastened on the top. This ring bears the centre lines, and must be securely fastened. If the guide-ring is struck up, a strickle will be required for this.

Moulding.

The tackle required for moulding may be found in the average foundry where general engineering castings are made. In the first place, a spindle centre is fastened to the foundation or bottom plate, as shown in Fig. 3. The reason for fastening the centre to the plate is to allow the spindle and strickle to be removed whilst stoving the job. The plate, with its centre attached, is set on levelled packings and the spindle placed in position. The arm and strickle are secured to the spindle and a course of bricks laid with open joints on the plate. The spaces between the bricks are filled with ashes or coke, which must be well rammed in. A ring or box part is placed on this course of bricks as at B, Fig. 3. The bottom bed and sides are then roughed and slipped up, the spindle and board removed and the whole incomplete mould is stoved or dried *in situ*. When dry, or partly dry and cooled, the spindle is replaced and the wood ring with the cross-pieces is set in position and weighted, as shown in Fig. 5. The tooth block is set to the first lot of centres and the first two teeth are rammed up, sprigged and vented, care being taken to see that the centres on the tooth block are in line with those on the ring. The block is lightly rapped and withdrawn, holding it towards the ring, thus taking advantage of the taper provided. The block is then set to the next set of centres and rammed up as before. This procedure is repeated all round the ring, and when all the teeth are made the ring may be removed and the mould finished, blacked and stoved. When ramming up the teeth care must be taken to see that no loose sand gets between the block and the ring or underneath same.



When the mould is dry it is removed from the stove to the foundry floor and is ready to receive the arm cores and centre core, splitting plates, etc., according to requirements. The top part of the mould is made either as a loam cake or may be rammed up in a top-part box. Where a loam-plate is used, it should be similar to the one shown in Fig. 2, with holes cast in to suit the runners and risers and spindle hole in the centre. If the plate is used for the top plate, it should be made with prods to carry the loam. The bottom plate may be plain, but with holes for the spindle and boltholes to secure the centre. To complete the mould, the cores are set and the top placed in position, the runner bush and risers made up, and the vents from the arm core are brought through holes in the plate, Fig. 2. The mould is then fastened down either with bolts or weights and is ready to cast.

Where the guide ring is made in loam the bottom of the mould is strewn with parting sand so that it can be removed easily when the teeth have been put on.

High-Wearing Welded-Steel Rails.—Application of the wear-resisting qualities of austenitic high-manganese cast steel in combination with structural-steel track work has been evolved by a firm in the United States. The rails are welded and reinforced with special plates and a solid manganese-steel casting is superimposed and welded in place to make a solid unit frog or crossover structure.—"Steel."

Relationship between Wall-Thickness, Test-Bar Diameter and Maurer Diagram for Cast Iron.

Since the structure and mechanical properties of cast iron are profoundly modified by the wall-thickness, *i.e.*, the cooling rate, in practical testing, it is most important to know the correct diameter of the test-bar, which really represents a casting of given wall-thickness. For mathematical considerations, it follows that for a test-bar and a casting of equal volume, the same cooling conditions prevail when the cooling surfaces are equal. Thus, a plate casting r in. thick is represented by a round bar of $2r$ in dia.

M. von Schwarz and A. Väth have shown in "Die Giesserei," issue No. 35, that this relationship holds good for wall-thicknesses up to 30 mm. Cylinder iron, engineering iron and iron high in phosphorus were cast in bars and plates of various thickness, and the castings tested for Brinell hardness and the number of graphite nuclei per unit of area. The bars were also broken in transverse. Each plate and the corresponding bar of double the thickness had about the same hardness and number nuclei. The 10-mm. plate of cylinder iron, for instance, had a hardness of 242 and 1,028 graphite nuclei per sq. mm., the bar of 20 mm. dia. a hardness of 232 and 1,248 nuclei. The 15-mm. plate of the high-phosphorus iron had a hardness of 185 and 251 nuclei, the 30-mm. bar a hardness of 180 and 238 nuclei. The cylinder iron showed the largest number of graphite nuclei at any wall-thickness, the high-phosphorus iron (1.4 per cent. P) the smallest, and, consequently, the coarsest graphite flakes. The fall in hardness with increasing wall-thickness was particularly high with the cylinder iron (from 300 at 5 mm. to 190 at 35 mm.), while the high-phosphorus iron showed a relatively low sensitiveness to thickness—the hardness fell from 230 at 5 mm. to 160 at 31 mm.

The above relationship between wall-thickness and test-bar diameter only applies to castings of relatively simple design. With intricate castings having small cores, conditions alter. Even with a very thin wall-thickness such a casting turns out softer, since the highly-heated cores retard cooling. The diameter of a test-bar representing an intricate cast must, therefore, be larger than results from the above formula.

With the test results gained from about 100 castings, the authors have revised the boundary lines of the pearlitic area in the Maurer diagram. With a normal superheat of 1,380 to 1,400 deg. C. and a total carbon content of 3.5 per cent., the limiting silicon contents are:—Wall-thickness 90 mm., 1.15 per cent.; wall-thickness 25 mm., 1.5 per cent.; wall-thickness 10 mm., 1.8 per cent. With a carbon content of 3.0 per cent. the corresponding figures are:—1.3, 1.75 and 2.0 per cent. of silicon. In sections thinner than 10 mm. it is very difficult to obtain a pearlitic structure. To get a machineable casting of, say, 5 mm. wall-thickness, it is necessary to raise the silicon content to 2.8 per cent. when the carbon content is 3.0 per cent. This high silicon content, together with the comparatively rapid cooling, give rise to the formation of eutectic graphite which is embedded in a ferritic ground mass. Irons high in phosphorus are less sensitive to the effects of superheat and wall-thickness, the pearlitic area is, therefore, displaced to higher silicon contents. For irons containing 1.1 to 1.4 per cent. of phosphorus and 3.5 per cent. of carbon, the limiting silicon contents are:—Wall-thickness 30 mm., 1.5 per cent.; wall-thickness 10 mm., 2.2 per cent.; wall-thickness 5 mm., 2.35 per cent. With a carbon content of 3.0 per cent. the corresponding figures are:—1.75, 2.35 and 2.7 per cent. of silicon.

This Week's News in Brief.

Trade Talk.

Messrs. William Firth & Company, iron and steel and machinery merchants, Leeds, have removed from 8, Hillary Place to 1, Lifton Place, Leeds, 2.

The Electricity Committee of the Manchester Corporation has prepared a report on the need for replacing the existing main switchgear at Stuart Street Power Station with a new installation at a cost of £225,000.

At a meeting of the members of the International Zinc Cartel at Brussels, on October 1, it was unanimously decided to continue the agreement with modifications regarding the method of the fines levied on excess production above quotas.

Sir William Arrol & Company, Limited, Glasgow, have secured the contract for the steelwork in the erection of a new bridge over the River Leven at Balloch, for the Dunbarton County Council. The engineers are Messrs. Blyth & Blyth, M.I.M.C.E., Edinburgh.

The Vulcan Tube Works of Messrs. Stewarts and Lloyds, Limited, at Motherwell, has received another large order which will keep the works fully employed for several weeks. The firm had recently to suspend many of the employees through lack of orders.

The Skoda Works of Plzen, Czecho-Slovakia, have secured a contract for the construction of seven iron and ferro-concrete bridges in Persia. They have also this year supplied the necessary plant for the equipment of the six new sugar factories which are being started in Persia.

Messrs. John Brown & Company, Limited, Clydebank, have received the contract for the first ship of the Admiralty's 1933 programme, a convoy ship. It is understood that the ship will have a displacement of about 1,500 tons, and will provide work for a large number of men for about 18 months.

From October 2, the name and address of Messrs. H. Cina & Son, 9, Robertson Lane, Glasgow, C.2, was changed to Associated Metal Works, 30, St. Andrews Square, Glasgow, C.1, to whom all communications should be sent. No alteration is to be made in the personnel of the company, which will assume and discharge all liabilities of the old company.

According to the monthly record of the Sheffield Chamber of Commerce, in the last ten weeks Sheffield has made and converted nearly 1,000 tons of steel more per working day than in the corresponding period of last year. The July output was 25,500 tons more than in July, 1932. The August working-day output, despite the holiday, was about 1,000 tons higher than in the previous month.

The dismantling of the huge electric power station at Port Dundas, Glasgow, has commenced. The station was erected in 1899, but with the materialisation of the electric-grid system, it has become superfluous. The whole plant and machinery has been purchased by George Cohen, Sons & Company, Limited, and the heavy and intricate task of dismantling the plant will provide work for a number of skilled and unskilled men.

Messrs. William Beardmore & Company, Limited, Parkhead Forge, Glasgow, have received a large order for plant and heavy forgings for the oil-from-coal plant to be erected by Imperial Chemical Industries, Limited, at Billingham. This, together with the heavy forgings required for Admiralty work at Dalmuir and a contract for a large number of tyres for South African railways, will ensure the forge being kept fairly well employed throughout a good part of 1934.

The shipment during the week of a large cargo of galvanised-steel sheets for the Argentine will complete a contract which has provided fully six weeks' employment for 400 men at the works of Messrs. Frederick Braby & Company, Limited, Springburn, Glasgow. The original order was for 400,000 galvanised flat sheets, each 5 ft. long by 18 ft. wide by 26 gauge, having a total weight of 1,000 tons. This represents something like 400 miles of sheeting—a good output for six weeks' work.

Since the Royal Charter was granted to the Institute of Marine Engineers in March last, an important alteration has been made in the regulations governing the admission of students. A detailed syllabus of the student examination has been issued, with particulars of exemptions open to candidates possessing certain educational qualifications. The next examination will be held in May, 1934. Particulars may be obtained from the secretary, Institute of Marine Engineers, the Minories, London, E.C.3.

The blast furnace at the ironworks of William Dixon, Limited, at Glasgow, was rekindled last week, when the works resumed operations after two years of inactivity. Preparations for the opening of the furnace have been proceeding for weeks. Adjacent to it stands another furnace which was erected years ago, but has never been in use. This cylinder awaits further improvement in trade, and is capable of producing 1,800 tons of pig-iron a week. "Dixon's Blazes," as the works are commonly known, are re-employing 150 men.

Falkirk Iron Company, Limited, at a recent sitting of the Falkirk Dean of Guild Court, were granted lining for alterations and re-roofing of their Castlelaurie Foundry. Dean of Guild Wallace, in intimating the decision of the Court, said that it gave them a great amount of pleasure to deal with the succession of petitions from foundries which had been before them recently. They would like to see these conditions continue, as they offered the prospect of additional employment for Falkirk foundry workers.

Company Reports.

Kayser, Ellison & Company, Limited.—Profit, £10,753; brought in, £9,078; preference dividend, £6,000; dividend on the ordinary shares of 1s. per share, or 1 per cent., absorbing £2,500; carried forward, £11,332.

Vulcan Foundry, Limited.—Manufacturing loss, £27,097; investment income, £19,884; profit on sale of securities, £23,073; profit after crediting rents, etc., received and deducting routine charges, £5,608; brought in, £28,158; from income-tax account, £9,405; dividend of 2½ per cent. on the ordinary shares; carried forward, £17,044.

British Piston Ring Company, Limited.—Net profit, £33,257; brought in, £8,155; interim dividend at the rate of 5 per cent. on the ordinary shares, together with the year's preference dividend, absorb £6,500; final ordinary dividend of 5 per cent., making 10 per cent. and absorbing £5,000, and a bonus of 10 per cent., requiring £10,000; to reserve account, £10,000; carried forward, £9,913.

Contracts Open.

Blidworth, October 19.—1,250 yds. of 6-in. cast-iron pipes, pumps, etc., for the Skegby Rural District Council. The Surveyor, Mr. L. Dodsley, Portland Chambers, Sutton-in-Ashfield. (Fee £2 2s., returnable.)

Cairo, December 18.—2,500 metres of 12-in., 3,000 metres of 4-in., and 1,000 metres of 3-in. spigot and socket cast-iron pipes and 1,090 metres of 2-in. galvanised-iron pipes, for the Egyptian Ministry of Public Works. The Department of Overseas Trade (Reference G.Y. 13,043).

Mexico, October 20.—27,000 metres of cast-iron pipe, for the Municipal Department of Mexico City. The Mexican Legation, London.

Sutton, Surrey, October 19.—Supply and laying of 9-in., 10-in. and 18-in. dia. cast-iron pipes, for the Sutton and Cheam Urban District Council. Mr. H. Bolton, clerk, Municipal Offices, Sutton, Surrey. (Fee £2 2s., returnable.)

Towyn, October 16.—1,870 yds. of 4-in. spun or cast-iron pipes with specials, etc., for the Urban District Council. Messrs. Sandford Fawcett & Partners, 53, Victoria Street, Westminster, S.W.1. (Fee £2 2s.)

New Companies.

Gussolit Fluxes, Limited, Southern House, Cannon Street, London, E.C.4.—Capital £7,500. Manufacturers of and dealers in accessories for the welding industry.

Thomas Francis & Company, Limited.—Capital £100. Malleable ironfounders, etc. Subscriber: T. Whitham, Meadow Croft, Otley Road, Bramhope, near Leeds.

Personal.

Mr. Frank Marsden, foundry manager with Messrs. Joseph Stubbs, Limited, of Manchester, has joined the board of directors.

Mr. Oliver J. White, mineral traffic manager of the Great Western Railway, retired on September 30, acting on medical advice.

Mr. James N. Cairns, of the warehouse department of Messrs. Smith & Wellstood, Limited, Bonnybridge, was the recipient of a presentation by his colleagues on the occasion of his marriage.

Mr. Franklin G. Smith, President of the Osborn Manufacturing Company, who is well known in Europe, has been elected a director of the American Foundry Equipment Manufacturers' Association.

Mr. G. H. Brooke, assistant to the managing director of Messrs. C. Akrill & Company, Limited, West Bromwich, has been appointed secretary of the Staffordshire Iron and Steel Institute in succession to Mr. S. J. Astbury.

Mr. W. H. Burns has retired after having completed 25 years' service as secretary of the Cleveland Institution of Engineers. He is succeeded by Mr. R. E. Cowell, a Middlesbrough consulting engineer. Mr. Cowell has previously held office as President.

Mr. James Barr, for many years a well-known figure in Clyde shipbuilding and engineering circles, will retire at the end of the year from the position of principal engineer surveyor for the British Corporation Register of Shipping and Aircraft. Mr. Barr joined the staff of the Corporation 35 years ago and was appointed to his present position 18 years ago.

Mr. A. Cozens Elliott, for ten years manager of the Foreign Department of Messrs. Sanderson Bros. & Newbould, Limited, Sheffield, recently received a presentation on leaving to take over the general secretaryship of the Institute of Linguists. Mr. Robert Beacroft, who is leaving after 34 years' service, also was the recipient of a presentation.

Mr. Robert Cowan, who has been associated for 45 years with Messrs. John Brown & Company, Limited, Clydebank, was entertained to dinner in Glasgow on September 30, by the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen on the occasion of his retirement. For the last 25 years Mr. Cowan has been head foreman of the machine department. He was presented with the diploma of the Association, of which he is a trustee.

Will.

Stewart, Alexander William, Kelvinside, Glasgow, and Craigownie Castle, Cove, engineer £200,696

Obituary.

Mr. Robert Wilson, who for 45 years was senior partner in the firm of Robert Wilson & Sons, now Wilson's Forge (1929), Limited, Bishop Auckland, has died at his home, aged 74.

Mr. Robert Lang, brassfounder, of Motherwell, has died in the Glasgow Royal Infirmary from injuries received when knocked down by a motor-car recently. He was 69 years of age.

The death has occurred at Back Burn, Letham, Angus, of Mr. George Watt, a well-known Letham personality. Mr. Watt, who was about 83 years of age, was a contractor and engineer, and was famous for the steel-hammer heads he produced.

Mr. John Davison, a director and general manager of the Barrow Hematite Steel Company, Limited, died at his home at Barrow on Saturday. Mr. Davison, who was 60 years of age, started his career at Consett, Durham, and became commercial manager of the Lanarkshire Steel Company, Limited, at Motherwell. He was a member of the National Committee set up last year to deal with the reorganisation of the iron and steel industry.

The death occurred, in Glasgow last week, of Mr. Alexander M'Laren, honorary treasurer of the Iron, Steel and Ironmongery Benevolent Association of Scotland, an organisation of which he was one of the founders. Mr. M'Laren was 74 years of age and a native of Dunblane. He came to Glasgow in 1874 as a member of the staff of Messrs. Dobbie, Forbes & Company, stove manufacturers, and remained in their employment for some 25 years. Subsequently he became associated with Messrs. Jones & Campbell, Limited, Torwood Foundry, Larbet, and was a member of their staff at the time of his death.

What is it worth to you?

TO SEE
your castings emerge from the Moulds with that "bloom" and "skin" that only ERITH gives.

TO KNOW
that once your formula and practice is settled ERITH will give you a progressively good result. No wasters, just a uniformly perfect job.

TO TRUST
the Sand you are using, being assured there will be no trouble to-day and none in the future. ERITH has never disappointed in 100 years.

TO HEAR
that ERITH LOAM will solve your problem. Castings from 1 lb. to 55 tons. Supplied throughout England, Scotland, Wales, America, Canada, Scandinavia, etc.

MAYBE IT CAN DO SOMETHING FOR YOU

Marketed in Six Grades:
MILD, YELLOW, MEDIUM, STRONG, EXTRA STRONG and WHITE SILICA for OIL CORES.

Complete Analyses, Samples and Quotations from :—

J. PARISH & CO., ERITH

ESTABLISHED 1805

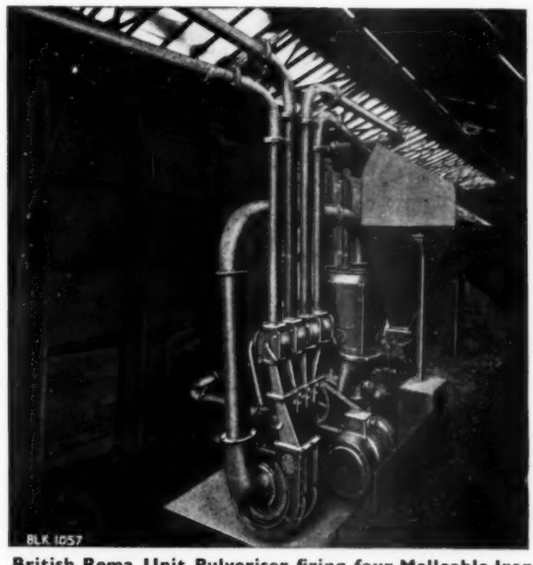
Pulverised Fuel Firing

offers the best and cheapest method of firing

MELTING FURNACES,
ANNEALING OVENS,
CORE STOVES, Etc.

BRITISH REMA

UNIT PULVERISERS
(Three types: Ring Roller, Ball Mill and Multiplex High Speed Mill)
and
GRID BURNERS
(Made under licence from H.M. Dept. of Scientific and Industrial Research)
ensure reliable and continuous operation



British Rema Unit Pulveriser firing four Malleable Iron Annealing Ovens.

Send for Illustrated Catalogue to :—

THE BRITISH REMA MANUFACTURING CO., LIMITED,
Hubert Street Works, Halifax, England.
London Representative: P. G. RYDER, First Avenue House, High Holborn, W.C.1.

Raw Material Markets.

Hopes of a gradual autumn expansion in the demand for iron and steel materials are now being realised. Although not a great deal of new business is now taking place in the pig-iron markets, substantial deliveries are being made to consumers under running contracts, in some cases into 1934. Generally speaking, the lighter sections of the consuming industries remain the best occupied. Prices of pig-iron are unchanged, but users have fears of a rise, in view of the strength of the coke and scrap-iron markets. It is expected that one or more additional furnaces will shortly be put into blast.

Pig-Iron.

MIDDLESBROUGH.—Free supplies of Cleveland pig-iron are becoming distinctly limited. Stocks at the makers' works have been greatly reduced, and the output of the two furnaces producing this grade is insufficient to satisfy the current demand. In some cases, hematite iron is being delivered in place of foundry. In these circumstances, an increase in output cannot be long delayed. As they are well contracted, the Middlesbrough ironmasters are not pressing for foreign business, which involves a considerable sacrifice in price. For local consumption the delivered price of No. 1 Cleveland foundry iron is 65s., No. 3 Cleveland G.M.B. 62s. 6d., and No. 4 foundry and No. 4 forge 61s. 6d. North of England buyers outside the Middlesbrough area pay 2s. per ton more than the above figures, while the delivery prices to Falkirk are based on No. 3 G.M.B. at 62s. 3d. and to Glasgow 65s. 3d. per ton. Pig-iron shipments from the Tees continue to show a steady improvement, the September total being 13,862 tons, which was 1,014 tons higher than in August. This total, with the exception of March, is the highest recorded this year. Coastwise clearances totalled 8,936 tons, of which 4,552 tons went to Scotland and 3,130 tons to South Wales.

The makers of East Coast hematite are heavily committed until the end of the year, and they are not pressing for business at the present quotations, which are 60s. for mixed numbers and 60s. 6d. for No. 1 quality. There are one or two merchants with fairly heavy holdings, and small sales have been negotiated at about 6d. per ton below the makers' prices.

LANCASHIRE.—During the past week or two, there has been a fair flow of pig-iron specifications for October delivery and further ahead, and market prospects are rather better. There has been a rise in the delivered price of East Coast hematite, the new quotation being about 75s. per ton. Other quotations are unchanged. For delivery to users in the Manchester area, Derbyshire, Staffordshire and Cleveland brands of No. 3 iron are all on offer on the basis of 67s. per ton, with Northants at 65s. 6d., Derbyshire forge iron at 62s., Scottish foundry at about 80s., East Coast hematite at around 75s., and West Coast at up to 81s. per ton.

It is stated that the dismantling of surplus Lancashire cotton mills is approaching its conclusion. This should mean a falling-off in the supply of cheap machinery scrap, which has been so excessive in this area, and has caused a decrease in the consumption of pig-iron.

MIDLANDS.—The fact that so many consumers are already contracted ahead for supplies is responsible for the lack of new business at the moment. The light-castings makers continue to be well-employed, and activity at the general engineering foundries is also picking up. Quotations remain at previous levels, namely, 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, Lincolnshire and North Staffs No. 3, including delivery to Black Country and Birmingham stations and subject to rebate. No control of prices has yet been announced for East Coast or Welsh hematite iron, although this has been expected for some time. The rates quoted delivered to this district are from 75s. 6d. to 80s., according to quality and the tonnage involved. West Coast hematite is controlled at 84s. 6d. per ton delivered this area for No. 3 or mixed numbers. Little or no Cleveland iron is now coming through; the existing quotation is round about 72s. 6d. The demand for special iron is at a fair level. Scottish No. 3 is quoted at 85s. delivered this area, medium-phosphorus iron from 70s. to 80s., low-phosphorus grades 80s. to 90s., and special refined iron from £5 to £6 15s.

SCOTLAND.—One or two makers report a slightly better demand for Scottish foundry iron, but the output of the four furnaces in blast is still sufficient for current needs, in conjunction with unsold stocks. It is reported that the Falkirk founders have been buying Cleveland foundry iron well into the first half of 1934, in order to assure themselves of supplies. There is no change to report in the official minimum of 65s. for No. 3 Scottish foundry at furnaces, with 2s. 6d. per ton additional for No. 1. Middlesbrough prices, for No. 3, are 62s. 3d. at Falkirk and 65s. 3d. at Glasgow, with Lincolnshire and Northamptonshire irons at 1s. 3d. to 2s. 3d. less.

Coke.

Although the coke market has shown a very strong tone lately, causing buying on the part of nervous consumers, there has so far been no alteration in prices. In the South Staffordshire area, best Durham coke is still at 36s. to 38s., with other grades at 34s. to 35s. and Welsh coke from 30s. to 45s., according to quality. There is a limited demand for Scottish low-ash foundry coke, which is offered at 38s. 6d. to 40s., also delivered South Staffs.

Steel.

In the steel markets, business is developing slowly, but steadily, the worst feature of the situation being the comparatively poor demand for shipbuilding material. In the semi-finished steel market business is on a good scale, and the producing works have a considerable tonnage of orders in hand. Now and again Continental material is offered at cheap prices, but the British makers are not perturbed by the amount of business going abroad. The demand for finished steel is irregular, and the works have to depend upon orders principally from home consumers, export business being upon a disappointing scale. Recently, however, there have been signs of an improvement in buying from some of the oversea markets and general inquiry has become more active.

Scrap.

The Cleveland scrap-iron market is developing an increasingly strong tone, and supplies are becoming limited in some directions, particularly as regards light metal. The demand for scrap in the Midlands is very regular, the ironfounders in that area being fairly busy. The call for machinery metal has fallen away slightly in Scotland, but there is a stronger demand for light cast iron. In South Wales, scrap iron suitable for foundry use is in rather quiet demand just now.

Metals.

Copper.—After revealing a stronger tone last week, due to a certain amount of buying of electrolytic metal by dealers, the market has passed through a quieter phase, and prices have declined, standard falling to £33 5s. on Wednesday. Consumers are displaying a certain amount of nervousness, largely owing to doubts about the outcome of the American situation. The attempts to get the Copper Code into working order are attracting great interest. The Geneva conversations with regard to evolving a scheme for the control of world copper production, on the lines of the new wheat pact, have drawn attention, but it is generally felt that the Empire producers would not be likely to bind themselves down at a time when their future prospects are better than they have ever been.

Estimates issued by the American Bureau of Metal Statistics show that the average monthly consumption of copper in Great Britain during the first eight months of this year has been 10,326 metric tons, as compared with 10,933 metric tons during the same period of 1932. The figures show that the general tendency during the same period in countries outside America has been for consumption to increase slightly.

The week's prices have been as follow :—

Cash.—Thursday, £35 to £35 1s. 3d.; Friday, £34 18s. 9d. to £35; Monday, £34 11s. 3d. to £34 12s. 6d.; Tuesday, £33 17s. 6d. to £34; Wednesday, £33 5s. to £33 6s. 3d.

Three Months.—Thursday, £35 5s. to £35 6s. 3d.; Friday, £35 2s. 6d. to £35 3s. 9d.; Monday, £34 15s. to £34 16s. 3d.; Tuesday, £34 1s. 3d. to £34 2s. 6d.; Wednesday, £33 8s. 9d. to £33 10s.

Tin.—Prices are very steady, and the market exhibits a confident tone, based mainly on the belief that world supplies of tin are still on the down-grade. The only cause of uncertainty continues to be the situation in the United States. In their weekly report, Messrs. Rudolf Wolff say that "it does not appear as if the international quotas would be increased in the near future, and with the world's supply diminishing continually, it looks as if higher prices might still be expected. Consumption continues satisfactory in America and Europe, but the uncertainty in the American position may bring about some selling and liquidation and discourage buyers."

Daily quotations :—

Cash.—Thursday, £224 15s. to £224 17s. 6d.; Friday, £224 10s. to £224 12s. 6d.; Monday, £224 7s. 6d. to £224 10s.; Tuesday, £224 17s. 6d. to £225; Wednesday, £223 17s. 6d. to £224 2s. 6d.

Three Months. — Thursday, £224 15s. to £224 17s. 6d.; Friday, £224 10s. to £224 12s. 6d.; Monday, £224 2s. 6d. to £224 5s.; Tuesday, £224 17s. 6d. to £225; Wednesday, £223 17s. 6d. to £224.

Spelter.—The spelter market has displayed a steady tone, although heavier offerings have been made on the London market lately. Consumptive buying has kept at a good level lately, thus accounting for the lack of fluctuation in quotations. Galvanised-sheet works are not so active now that the Argentine locust-barrier orders have been completed.

Price fluctuations :—

Ordinary.—Thursday, £16 13s. 9d.; Friday, £16 15s.; Monday, £16 15s.; Tuesday, £16 13s. 9d.; Wednesday, £16 10s.

Lead.—Good supplies and a steady demand from consumers are responsible for the continued steadiness of prices. The contemplated expenditure of £95,000,000 by local authorities during the next five years in connection with the national slum-clearance campaign is interpreted as a "bull" point for the lead industry, as the rebuilding will involve large amounts of lead sheeting and piping. Lead consumption in U.S.A. remains at an improved level.

Daily market prices :—

Soft Foreign (Prompt). —Thursday, £12 1s. 3d.; Friday, £12 2s. 6d.; Monday, £11 17s. 6d.; Tuesday, £11 17s. 6d.; Wednesday, £11 16s. 3d.

Notes from I.B.F. Branches.

Scottish Branch.—The opening meeting of the session will be held in the Royal Technical College, George Street, Glasgow, on Saturday, October 14, at 4 p.m., when the newly-elected President, Mr. J. Currie, will deliver his Presidential Address. Mr. J. E. Hurst, Junior Vice-President of the Institute, will read a Paper on "Nitricastiron." At the conclusion of the meeting the members, with their ladies and friends, will attend a social function in the Ca'doro Restaurant, Union Street, Glasgow.

Furnace Roofs.—K. Harraeus, of the German Patent Office, has issued a small book dealing with the construction of furnace roofs, which reviews current practice as well as recent improvements.

Foundry Exhibition, Agricultural Hall, April 24 to May 3, 1933.—Will the firm which gave to Messrs. Long, Humphreys & Company, Limited, of Chertsey, Surrey, a sample chaplet of the two discs on a nail stem type please communicate with them?

"Hints for Crane Drivers."—On page 170 of a recent issue we printed a number of rules for the guidance of crane drivers. This was noted by Mr. M. R. Meldrum of Messrs. Herbert Morris, Limited, of Loughborough, who has very kindly sent us a substantial cardboard wall chart, which illustrates a series of signals necessary for the safe operation of electric cranes. We think these signals are excellent as they have the real advantage of being natural indicative motions. This means that if a crane driver came down to the floor to conduct operations, they are the very signs he would employ naturally.

XUM

Compare these actual test figures and you will realise the economies of the Buell system of pulverised fuel firing . . . .

The figures given in the Table at the right are certified representative test data of the operations of a forge reheating furnace after many months' operation under actual industrial conditions. The furnace in question was hand fired and steam blown before the adoption of pulverised coal. *Industrial executives are invited to write for further data to:*

The Buell Combustion Co Ltd
49, MOORGATE, LONDON, E.C.2
Telephone: Metropolitan 7751.
Works: EDGAR ALLEN & CO., LTD., Imperial Steel Works, Sheffield.

FORGE REHEATING FURNACE	HAND FIRING	BUELL PULVERISED FUEL SYSTEM
Calorific value of coal	13,500 B.T.U's	12,000 B.T.U's
COST PER TON DELIVERED	20/-	10/6
Working period per day	24 hours	24 hours
COAL CONSUMPTION PER HOUR	3·5 cwts.	2·4 cwts.
Period of reheating required	20 hours	15 hours

WARNER
PIG IR
"The brand of proved rel
Supplied to specifications covering a wide range of requirements and employed by the leading Railway Co's Roll Makers and Engineering Founders.
WARNER &
CARGO FLEET

RAW MATERIALS—PRICE LIST.

(Wednesday, October 11, 1933.)

COPPER.

	£	s.	d.
Standard cash	33	5	0
Three months	33	8	9
Electrolytic	36	10	0
Tough	35	0	0
Best selected	35	10	0
Sheets	64	0	0
India	45	0	0
Wire bars	37	0	0
Ingot bars	37	0	0
H.C. wire rods	39	0	0
Off. av. cash, September	35	3	7 3/4
Do., 3 mths., September	35	7	3½
Do., Sttlmnt., September	35	3	8½
Do., Electro, September	38	13	10½
Do., B.S., September	38	3	7½
Do., wire bars, September	39	0	11½
Solid drawn tubes			10¼d.
Brazed tubes			10¼d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7¾d.
Wire	7¾d.
Rolled metal	7¼d.
Yellow metal rods	4¾d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN.

	£	s.	d.
Standard cash	223	17	6
Three months	223	17	6
English	224	10	0
Bars	226	0	0
Straits	231	0	0
Australian (nom.)			—
Eastern	228	0	0
Banca	228	10	0
Off. av. cash, September	216	19	3½
Do., 3 mths., September	216	18	4½
Do., Sttlmt., September	216	19	0½

SPELTER.

	£	s.	d.
Ordinary	16	10	0
Remelted	16	5	0
Hard	14	0	0
Electro 99.9	19	2	6
English	17	7	6
India	16	0	0
Zinc dust	20	0	0
Zinc ashes	3	15	0
Off. aver., September	16	18	6½
Aver. spot, September	16	16	2½

LEAD.

	£	s.	d.
Soft foreign ppt.	11	16	3
Empire	12	2	6
English	13	5	0
Off. average, September	12	1	7½
Average spot, September	11	18	7½

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	25	15	0
Do., V.M. ex whse.	25	5	0
Rods	30	10	0

ANTIMONY.

	£	s.	d.		£	s.	d.
English	37	10	0	to 40	0	0	
Chinese, ex-whse.				26	10	0	
Crude				20	10	0	

QUICKSILVER.

	£	s.	d.		£	s.	d.
Quicksilver	9	5	0	to 9	15	0	

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£6 10 0
45/50%	£12 10 0
75%	£18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
2/4% car.	£25 10 0
4/6% car.	£21 17 6
6/8% car.	£19 7 6
8/10% car.	£18 17 6
Ferro-chrome—	
Max. 2% car.	£29 15 0
Max. 1% car.	£30 17 6
Max. 0.70% car.	£35 15 0
70%, carbon-free	9½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	½ lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel				2	10	0	
Bundled steel and shrngs.	1	17	6	to 2	9	0	
Mixed iron and steel	2	5	0	to 2	6	6	
Heavy cast iron	2	5	0	to 2	6	6	
Good machinery	2	7	6	to 2	10	0	
Cleveland—							
Heavy steel				2	6	0	
Steel turnings				1	11	6	
Cast-iron borings				1	2	0	
Heavy forge				2	10	0	
W.I. piling scrap				2	0	0	
Cast-iron scrap	2	5	0	to 2	7	6	
Midlands—							
Light cast-iron scrap	1	18	6	to 2	0	0	
Heavy wrought iron				2	10	0	
Steel turnings, f.o.r.	1	6	6	to 1	7	6	
Scotland—							
Heavy steel	2	6	3	to 2	7	6	
Ordinary cast iron				2	7	6	
Engineers' turnings				1	14	0	
Cast-iron borings				1	15	0	
Wrought-iron piling				2	5	0	
Heavy machinery	2	10	0	to 2	11	0	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	30	0	0
Brass	20	0	0
Lead (less usual draft)	11	0	0
Tea lead	8	5	0
Zinc	11	0	0
New aluminium cuttings	73	0	0
Braziery copper	27	0	0
Gunmetal	26	0	0
Hollow pewter	137	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	60/6
Hematite M/Nos., f.o.t.	60/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	74/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	0	0	to 9	15	0	
Nut and bolt iron	6	15	0	to 7	10	0	
Hoops	10	10	0	to 12	0	0	
Marked bars (Staffs) f.o.t.				12	0	0	
Gas strip	10	10	0	to 12	0	0	
Bolts and nuts, ¾ in. × 4 in.	13	5	0				
Steel—							
Plates, ship, etc.	8	15	0	to 8	17	6	
Boiler plts.				8	5	0	
Chequer plts.				10	7	6	
Angles				8	7	6	
Tees				9	7	6	
Joists				8	15	0	
Rounds and squares, 3 in. to 5½ in.				9	7	6	
Rounds under 3 in. to ⅜ in. (Untested)	6	17	6	& up.			
Flats—8 in. wide and over				8	12	6	
,, under 8 in. and over 5 in.				8	17	6	
Rails, heavy	8	5	0	to 8	10	0	
Fishplates				12	0	0	
Hoops (Staffs)	9	10	0	& up.			
Black sheets, 24g. (4-t. lots)				10	5	0	
Galv. cor. shts. (,,)				12	15	0	
Galv. flat shts. (,,)				13	5	0	
Galv. fencing wire, 8g. plain				14	0	0	
Billets, soft	5	5	0	to 5	12	6	
Billets, hard	6	12	6	to 7	2	6	
Sheet bars	5	0	0	to 5	5	0	
Tin bars				5	0	0	

PHOSPHOR BRONZE.

	Per lb. basis
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12½d.
Rods	11d.
Tubes	15½d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	18.34
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic	18.89
Bessemer	19.89
Malleable	19.39
Grey forge	19.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.75
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.10
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.65

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	14/- to 15/-
Durham foundry	21/- to 25/-
,, furnace	14/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	16/6 to 17/-
,,	28×20 ,,	33/- to 34/-
,,	20×10 ,,	23/9 to 24/3
,,	18¾×14 ,,	17/3 to 17/9
C.W.	20×14 ,,	15/3 to 15/9
,,	28×20 ,,	32/- to 32/6
,,	20×10 ,,	22/7½ to 22/9
,,	18¾×14 ,,	16/3 to 16/6

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.		£	s.	d.
Pig-iron	6	0	0	to £7	0	0	
Bars-hammered, basis	£16	0	0	to £16	10	0	
Bars and nail-rods, rolled, basis	£15	15	0	to £16	0	0	
Blooms	£10	0	0	to £12	0	0	
Keg steel	£30	0	0	to £31	0	0	
Faggot steel	£18	0	0	to £23	0	0	
Bars and rods dead soft, st'l	£10	0	0	to £12	0	0	

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Oct. 5 ..	35	0	0	inc. 2/6
,, 6 ..	34	18	9	dec. 1/3
,, 9 ..	34	11	3	,, 7/6
,, 10 ..	33	17	6	,, 13/9
,, 11 ..	33	5	0	,, 12/6

Electrolytic Copper.

	£	s.	d.	
Oct. 5 ..	38	5	0	No change
,, 6 ..	38	5	0	,, ,,
,, 9 ..	37	15	0	dec. 10/-
,, 10 ..	37	5	0	,, 10/-
,, 11 ..	36	10	0	,, 15/-

Standard Tin (cash).

	£	s.	d.	
Oct. 5 ..	224	15	0	inc. 60/-
,, 6 ..	224	10	0	dec. 5/-
,, 9 ..	224	7	6	,, 2/6
,, 10 ..	224	17	6	inc. 10/-
,, 11 ..	223	17	6	dec. 20/-

Tin (English ingots).

	£	s.	d.	
Oct. 5 ..	225	5	0	inc. 55/-
,, 6 ..	225	0	0	dec. 5/-
,, 9 ..	225	0	0	No change
,, 10 ..	225	10	0	inc. 10/-
,, 11 ..	224	10	0	dec. 20/-

Spelter (ordinary).

	£	s.	d.	
Oct. 5 ..	16	13	9	inc. 1/3
,, 6 ..	16	15	0	,, 1/3
,, 9 ..	16	15	0	No change
,, 10 ..	16	13	9	dec. 1/3
,, 11 ..	16	10	0	,, 3/9

Spelter (Electro, 99.9 per cent.).

	£	s.	d.	
Oct. 5 ..	19	2	6	inc. 2/6
,, 6 ..	19	5	0	,, 2/6
,, 9 ..	19	5	0	No change
,, 10 ..	19	2	6	dec. 2/6
,, 11 ..	19	2	6	No change

Zinc Sheets (English).

	£	s.	d.	
Oct. 5 ..	25	15	0	No change
,, 6 ..	25	15	0	,, ,,
,, 9 ..	25	15	0	,, ,,
,, 10 ..	25	15	0	,, ,,
,, 11 ..	25	15	0	,, ,,

Lead (English).

	£	s.	d.	
Oct. 5 ..	13	10	0	No change
,, 6 ..	13	10	0	,, ,,
,, 9 ..	13	5	0	dec. 5/-
,, 10 ..	13	5	0	No change
,, 11 ..	13	5	0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 0 0	6 0 0	6 2 6	6 2 6	6 2 6	6 0 0	6 0 0	6 0 0	6 0 0	6 2 6	6 10 0	6 10 0	6 2 6
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 15 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	13 11 0	13 5 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	—	—	—	—

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